THURSDAY, DECEMBER 23, 1915.

THE "WHEAT PROBLEM" AND SYNTHETIC NITRATES.

MANY years have elapsed and much water has flowed under the bridges since Sir William Crookes startled a heedless world by an address, delivered in his capacity as president of the Bristol meeting of the British Association, in which he drew a somewhat alarming picture of "the serious peril awaiting wheat-eaters who contentedly pursue the present wasteful system of cultivation." He stated that in his opinion under present conditions of culture a scarcity of wheat is within appreciable distance; that wheat-growing land all over the world is becoming exhausted, and that at some future time—in his opinion not far distant—no available wheat land will be left. The prediction was as doleful as the prospect was disquieting; but fortunately the remedy was comparatively simple and it was near at hand. As the president pointed out, Nature's resources, properly utilised, were ample. The remedy consisted in a more scientific cultivation and, in particular, in the application of so-called chemical manures, whereby, by moderate dressings, the then average world-yield of 12·7 bushels per acre would be increased to 20 bushels —"thus postponing the day of dearth to so distant a period that we, our sons, and grandsons may legitimately live without undue solicitude for the future."

The main contention of this address was not allowed to pass without vigorous criticism, and a year later Sir William Crookes returned to the charge with a small volume[1] in which he set out in greater fulness the data on which his conclusions were based, with, however, the depressing result that he was unable, in any material degree, to modify his estimates of the future producing capacity of the wheatfields of the globe.

The whole question is of particular interest at this present juncture, when the production and distribution of wheat have been seriously affected by the convulsion which has overtaken the world. Large areas in Europe have for a time gone out of cultivation, and other districts, as in Russia and Rumania, are precluded from bringing their supplies to the world's markets. A vast economic disturbance has resulted in an extraordinary and altogether abnormal inequality of prices. Perhaps no valid comparison is possible between a world at peace where economic causes reach their legitimate and natural effects, and a world at war when almost every economic law is broken or set at defiance. Still, it would be reassuring to know that, in spite of the forebodings to which "The Wheat Problem" gave rise, measures are being taken to dispel them. As already stated, Sir William Crookes revealed to a prospectively famishing world how it might escape the horrors of starvation. "Starvation," he said, "may be averted through the laboratory. Before we are in the grip of actual dearth, the chemist will step in and postpone the day of famine." How was he to do it? By a "dominant" manure—in this case some form of fixed nitrogen.

Now, whatever may be the real interpretation of the facts to which we have referred, or whatever the intrinsic merit of the arguments based upon them—and it cannot be said, even after the lapse of the seventeen years which have intervened since the address was delivered, that the question has been definitely settled—it is common ground that a wheat supply may be materially enhanced by the intelligent application of nitrogenous manures, one of the most important of which is sodium nitrate or so-called Chile saltpetre. This fact is universally recognised; but it is not so generally understood that the present natural sources of sodium nitrate are by no means limitless. Even now the rich beds in the rainless districts in the northern provinces of Chile between the Andes and the coast hills have been nearly worked out. It is true that when the raw "caliche," containing from 25 to 50 per cent. nitrate, is exhausted at no very distant date, there is a lower grade of material which may be worth working. But the broad fact remains, and we cannot escape from it, that the time is approaching when we must seek some other sources of supply. So far as we know, the world has no other sources of the naturally occurring product than Chile. We must therefore look to the laboratory, and we have a confident hope that the chemist will not fail us. The synthetic production of nitrates, adumbrated by a scientific use of the imagination, so far back as 1898, is now an accomplished fact and a commercial possibility. Processes are at work in various countries, and Germany, we are told, is now independent of all outside sources of nitrates, and her manufacturers have made such

[1] "The Wheat Problem." By Sir William Crookes, F.R.S. (London: John Murray, 1899.)

terms with their Government that they have been able to establish a permanent industry protected from outside competition.

In the meantime, so far as we have been able to gather, this country is doing nothing in this matter. It may be that it is incapable of doing anything, as natural conditions may be against us. But it is difficult to see why we are worse off in this respect than Germany. Energy can be produced as cheaply in this country as in Germany, if not cheaper, and the problem as a commercial matter is largely a question of cheap electrical energy. We have the same ample supply of nitrogen and oxygen in our atmosphere as Germany, and soda is at least as cheap with us.

The whole question needs systematic examination, and it is the object of this article to commend it to the careful and serious consideration of one of the scientific committees which have been established since the outbreak of war. There is surely no more pressing or important problem in the interests of the future welfare of this country, intimately bound up as it is with the prosperity of our agriculture, the oldest and most vital of our industries. We have amongst us men—chemical engineers and electrical engineers—who can deal adequately with this subject, and they could confer no greater national benefit than to enlighten the manufacturing community concerning the possibilities of the synthetic production of nitrates in this country as a commercial enterprise, after a careful and impartial consideration of all available facts.

This is a matter which intimately concerns the Board of Agriculture, and it might appropriately be considered by the Departmental Committee appointed by the president of the Board a few weeks ago "to make arrangements with a view to the maintenance, so far as possible, of adequate supplies of fertilisers for the use of farmers in the United Kingdom." We do not recognise a chemist among the members of the committee, and conclude, therefore, that the possibilities of producing a supply of synthetic nitrates are not to be contemplated. If the omission is deliberate, we suggest that the subject should be taken up by the British Science Guild, or by one of the committees recently appointed by the Government and by scientific societies, so that a definite view of our national position in this matter may be presented and provision may be made for any eventualities which the future may bring, either during the war or in later years.

THE FAUNA AND FLORA OF CENTRAL AMERICA.

Biologia Centrali Americana. Zoology, Botany, and Archæology. Edited by F. D. Godman and O. Salvin. (London: Dulau and Co., Ltd., 1879–1915.)

THE first and last volumes of this magnificent work have recently appeared, and as it is impossible to review adequately sixty-three volumes, even if one took up several numbers of NATURE, the following attempt will be confined to the first or introductory volume, which has recently been issued under the editorship of Mr. Godman.

When this great work was first planned it was estimated that the zoological part would not exceed twelve volumes of five hundred pages each, and that four volumes would suffice for Botany; the inclusion of the Archæology was not at that time contemplated. These sixteen volumes have, however, swollen into sixty-three volumes, including a most valuable contribution by Mr. A. P. Maudslay on the archæology, ruins, and inscriptions of Yucatan.

It is not unusual for a rich patron—a modern Mæcenas—to subsidise publications on an extensive and even lavish scale. It is less usual to find the patron and investigator in one and the same man, but, in fact, it is mainly due to the public spirit and the scientific ardour of Mr. Godman that this very important contribution to biological science has been so successfully carried through.

Godman and Salvin belonged to a small group of Cambridge undergraduates who, in the middle 'fifties, took a keen interest in natural history. In the neighbouring and then undrained fenland they once even chased a buzzard, and "were just too late to catch the 'large copper,' recently become extinct." These youthful naturalists were wont to meet in each other's rooms and discuss their various "finds," and, indeed, it was in Newton's rooms at Magdalene, towards the end of 1858, that Salvin, Simpson, Wolley, Slater, Newton, and others met and passed a resolution founding the Ornithological Union, the journal of which, *The Ibis*, has now reached its fifty-sixth volume.

Salvin had already travelled in northern Africa and northern Europe when in 1857 he paid his first visit to Central America, and first became acquainted with the collectors who were then active in these regions. Two years later he returned again; and two years afterwards Godman joined Salvin on his third expedition to Guatemala. Again in 1867, accompanied by his wife, Salvin returned for a fourth time to Guatemala, and after

coming back *viâ* the United States in 1875 was appointed Strickland Curator of the Bird Room in Cambridge.

Salvin's removal to Cambridge necessitated his giving up his house in South Kensington, which had served as a museum and library for the Central American collections, then very rapidly accumulating. To replace this centre a house was taken in Tenterden Street, Hanover Square, and for some years this was the home of hard work and much instructive conversation and debate, for after the scientific meetings of the Zoological Society in the neighbouring square the ornithologists frequently repaired hither to exchange views, criticisms, and ideas.

The area of the New World which is dealt with in this series of monographs "includes the whole of Mexico south of the Rio Grande as far as El Paso, and thence to the Gila river, and following it as far as the Gulf of California." Some of the neighbouring islands the sea-birds of which are common to those in the adjacent mainland are also included. The whole of Central America, comprising British Honduras, Guatemala, southern Honduras, Nicaragua, Costa Rica, and Panama, come within the area. In shape the area has been compared to a cornucopia, narrowing from the northern breadth of 1140 miles to 45 miles at the isthmus of Panama. From a climatic point of view the area is divided into three zones, the Tierra Caliente, the Tierra Templada, and the Tierra Fria, the middle term of which corresponds roughly with an elevation of 3000 to 5000 feet. But these limits vary on the Pacific and the Atlantic coasts, the greater rainfall on the latter producing a much more luxuriant vegetation than is found on the western slopes. Although the present connection between the North and South American continents is by way of the Central American isthmus, the same does not apply to the tectonic connection. Geologically, the true union of North and South America is through the Antilles, these islands being the peaks of a mountain range which forms the true link between the coast ranges of North America and the Andean chain of South America, although even this cannot be said to be a direct continuation of either of them. The isthmus, as a connecting link, is of later date, due to various complex phases of earth-movement, so that the Caribbean Sea, although now forming part of the Atlantic, was in its past history more closely bound up with the Pacific Ocean.

In the region in question, the formations consist of Tertiary deposits, fossiliferous limestones, sandstones, and clays, together with igneous rocks and ashes, these being similar to those found in the coast ranges and in the Andes. Nowhere in the Central American mountains is any pre-Tertiary core exposed, such as is found in many of the mountains of that period elsewhere. The main movements seem to have been completed by the close of the Miocene times, as Pliocene and more recent deposits are only found at comparatively low elevations, and have not been involved in the major movements. The most recent movements have given rise to the coastal plains, which are specially well marked on the Atlantic side of the isthmus.

Although Godman and Salvin between them covered in their travels but a small part of the extensive area in question, Mr. Godman has given a peculiarly complete and fascinating account of the physical feature of the "terrain," the fauna and flora of which they investigated, since the former has rightly used the field-notes and records of their numerous collectors and other naturalists who have worked in Mexico and Central America.

If we exclude the botanical volumes, and Mr. Maudslay's monograph on Archæology, we shall find the work deals in the main with Vertebrate and Insect forms, and among the vertebrate the birds especially stand out. The total number of species of Mammalia is described as 181, and as Dr. Sclater remarked:

"It may fairly be said that (excluding the introduced Mures), at least one hundred of the constituent species are essentially Neotropical in their character, or have Neotropical affinities, while of the remainder not more than sixty can be said to be decidedly Nearctic. There is, therefore, no doubt that the Central American isthmus, at any rate as far north as Tehuantepec, should be assigned to the Neotropical region."

More than 1400 species of birds were enumerated, of which nearly one-half were endemic. The Reptiles and Batrachia yielded just under 700 species.

As regards the geographical distribution of these animals, Dr. Günther remarks that:—

"A boundary line between the North and South American regions cannot be drawn. Central America forms a transition-tract, unlike any other part of the world, showing the most extraordinary diversity of climatic, physical, and meteoric conditions within comparatively small areas, favouring the evolution of a great variety of types of genera and species."

Mr. C. Tate Regan has been responsible for an admirable monograph on the Pisces. He also associates Central America with the Neotropical region.

Amongst the Invertebrates, besides the insects

mentioned already, the Molluscs form the subject of a monograph by E. v. Martens. Unfortunately the Crustacea have not been studied, the late Prof. T. H. Huxley being unable to finish the fresh-water Malacostraca, which he had hoped to describe. The Spiders, Harvestmen, Scorpions, Pedipalps, and, to a certain extent, Mites and Centipedes, have, however, been fully worked out. As is so often the case, the Beetles, which numbered more than 18,000 species, receive special notice, and indeed the Coleoptera and the Lepidoptera were the only two groups for which sufficient specialists were forthcoming to describe the collections completely. The Hymenoptera, unfortunately, have not been fully examined, and the Bees and Social Wasps have had to be passed by. The Diptera, again, yielded comparatively few species, and the same is true of the Orthoptera.

The whole world benefits by this series of stately tomes, but the debt of our country is even deeper, for all the collections brought together with so much care and cost now repose in the British Museum (South Kensington). We cannot refrain from including the following quotations in this short notice:—

"All the insects from Mexico and Central America, the Sallé and Janson collections of beetles, our own general collection of birds and butterflies, and the Henshaw collection of birds, have been presented by us to the British Museum, and are being gradually incorporated with the National Collection."

"The various accessions are enumerated in detail in vol. ii. of the 'History of the Collections contained in the Natural History Departments of the British Museum' (1906), and in the subsequent annual reports of that Institution. The first instalment of Neotropical birds (50,120 specimens) was presented in January, 1885, and other instalments followed from time to time until the whole of them became the property of the nation. Amongst the insects, up to 1906, the total number of specimens given in the 'History' is as follows; Coleoptera (85,920), Lepidoptera Rhopalocera (17,829), Lepidoptera Heterocera (12,883), Diptera (17,525), Hymenoptera (10,004), Rhynchota Heteroptera (5543), etc. These figures do not include the Rhynchophora or weevils (22,793), the Staphylinidæ and water-beetles (9474), the Odonata (3000), the Rhynchota Homoptera (5509), the supplementary unworked parasitic Hymenoptera (6293), etc. From 1906 onwards the remaining collections have been handed over to the Museum as soon as the enumeration of the species was completed; that of the Coleoptera was finished in 1911. Our own general collection of butterflies probably included nearly 100,000 specimens, and the beetles alone from Mexico and Central America perhaps double that number. Besides these a considerable number of mammals, reptiles, fish, etc., of which no account was kept, were presented to the National Museum."

The "Biologia Centrali Americana" must ever remain a classic. Biological science owes a deep debt to those who planned, designed, financed, and carried out this truly monumental work. In every sense of the word it is a credit to the British nation, and we only wish that Mr. Salvin had lived to share with his collaborator the widespread recognition of the great services they have rendered to their science and to their country.

FOSSIL MAN.

The Antiquity of Man. By Prof. A. Keith. Pp. xx + 519. (London: Williams and Norgate, 1915.) Price 10*s.* 6*d.* net.

THE chief works on the antiquity of man have hitherto been written by geologists and archæologists. Prof. Keith now treats the subject from the point of view of the human anatomist. The available facts and speculations of geology and archæology are all briefly stated and introduced at appropriate stages in the argument; but the anatomical characters of the various known human remains and their significance form the author's main theme. The plan has obvious disadvantages, for the value of the conclusions depends on the authenticity of the materials, which none but an expert geologist can determine. It also fosters a tendency to make dogmatic statements about the age of the various remains in terms of years, which may please a section of the inquisitive public but cannot be admitted as science. At the same time, the human anatomist is an essential factor in unravelling the story of primitive man, and Prof. Keith has produced an important work, which is all the more fascinating since it is the direct outcome of his own personal observations.

The great interest of Prof. Keith's volume, indeed, depends on the insight it affords into the methods and aims of modern research in prehistoric anthropology. It is sometimes technical and tedious, but the whole is written with the inspiring enthusiasm of an investigator, and it is enlivened by many personal touches when describing the circumstances of the different discoveries. The general reader will also be much helped in the comparison of the human skulls and jaws by the author's method of placing his numerous figures in rectangular frames of standard size.

Prof. Keith begins with the long-headed men of Neolithic times, and observes that they exhibit no primitive features in their skeleton. He de-

scribes the circumstances in which undoubted Neolithic remains were found in the megalithic monument of Coldrum, Kent, and then deals with several other examples, including the famous Tilbury skeleton, which he refers to the beginning of the Neolithic period. He next considers some of the well-attested human remains from the latest Palæolithic deposits, such as the skeleton from Paviland cave, Glamorganshire, and the well-known skulls from Engis, near Liège, and from Cromagnon in the Dordogne valley, France. These also are shown to agree with the corresponding parts of existing European man; though certain skeletons found in the Grimaldi caves, near Mentone, which seem to belong either to the same or to a closely-allied race, differ a little from all European skeletons, and exhibit some negroid features. In the skulls, however, the right and left eminences of the forehead are not fused together into a peculiar single boss as is the case in typical negroes. Prof. Keith therefore thinks that the Grimaldi type may, perhaps, be most nearly represented in the modern world, not by negroes but by the tall races of the Punjab, India. He also assigns to the late Palæolithic period a skeleton from Halling, Kent, skeletons from the Cheddar caves and Cissbury, a skull from a cave at Langwith, Derbyshire, and other fragments about the age of which geologists are by no means agreed. None of these remains exhibit any essential differences from modern English human skeletons, and it is very uncertain how many of them have been introduced into Palæolithic deposits by comparatively recent burial. Prof. Keith, indeed, soon proceeds to forfeit confidence in his conclusions by the dogmatic manner in which he accepts remains of doubtful authenticity, such as the much-discussed skeletons from Galley Hill (Kent) and Ipswich. He even states that he regards the Palæolithic age of the Galley Hill skeleton as a certainty (p. 250). No geologist would do more than place such remains in a "suspense account," and the majority would probably ignore them altogether.

The concise chapters on Neanderthal man give an excellent summary of the latest researches on this strange extinct species, and Prof. Keith is now of opinion that he cannot be included in the direct ancestry of modern man. The massive mandible of Heidelberg man is considered to represent "a primitive variety" of the Neanderthal race. Evidence of fossil man from Africa and Asia is described as disappointing, but Pithecanthropus is considered to be one of the Miocene types of ancestral man which survived to a later date on the island of Java.

After a brief reference to the unsatisfactory nature of the discoveries of fossil man in North and South America, Prof. Keith devotes the remainder of his volume to an extended discussion of the skull and mandible of Piltdown man, or Eoanthropus. This discussion, in fact, is so extended that it tends to become discursive, and to obscure whatever conclusions it is intended to convey. It is only evident that when the remains of an extinct genus of Hominidæ are to be interpreted, the experience of a vertebrate palæontologist is needed to supplement and modify the ordinary methods of the human anatomist. Prof. Keith has now so altered his first restoration of the Piltdown cranium that the brain-capacity is reduced to about 1400 c.c., while the mandible has become essentially identical with that reconstructed by Dr. Smith Woodward. In his Figs. 176 and 185 he even shows the upstanding large lower canine tooth being worn by the upper canine, although on p. 459 he still maintains that the wearing must have been due to the upper lateral incisor. Mr. Charles Dawson's discovery of Eoanthropus, however, has raised problems of such difficulty that differences of opinion as to its interpretation will continue until less imperfect remains are forthcoming; and all students will welcome Prof. Keith's detailed statement of the questions involved. As to his more general conclusions in the final chapter of the book, geologists and palæontologists at least will hesitate to accept them on account of the doubtful nature of much of the evidence on which they are founded; but all will realise their indebtedness to Prof. Keith for an inspiring new view of an old and perplexing subject. A. S. W.

THE WAR AND THE FUTURE.

The War and After. Short Chapters on Subjects of Serious Practical Import for the Average Citizen in A.D. 1915 Onwards. By Sir Oliver Lodge. Pp. xiii+235. (London: Methuen and Co., Ltd., 1915.) Price 1s. net.

THE little volume which Sir Oliver Lodge has written is of interest from more than one point of view. The author frankly confesses that he has "no pretension to be an historian"; and in the first section of his book he has borrowed from many authors in order to present a picture of "The Past." The result is, to some extent, a patchwork; but the quotations are skilfully dovetailed into the text, so that the general effect is not so uncouth as might be feared. The second portion of the book, "The Present," deals with problems such as those presented by aggressive and defensive wars, savagery, pacifism, material prosperity, and self-

interest; and here the book has more direct bearing upon present-day affairs.

The average reader will turn with most interest to the third section, "The Future"; and in it he will find much to stimulate thought. It would be too much to expect a general agreement with all the views advanced by the author; but whether one differs from him or not, his book will serve a useful purpose in compelling people to think out certain problems which must arise before many months have passed. Sir Oliver Lodge is frankly an optimist; but his optimism does not blind him to the difficulties which will lie before this country when the war is over. He discusses the question of social unrest, traces its roots in the present industrial conditions, and suggests one or two points at which improvements might be made; but the limited space at his disposal has obviously led to a curtailment of this part of the book. He asks that science shall not be forced "to grub along like a sort of Cinderella, called in occasionally when the housework has to be done, but otherwise left to sit among the ashes and brood"; but the turn of his phrases seems to hint that, like most of us, he has little hope of any immediate improvement in this direction.

Apart altogether from its subject-matter, the volume is interesting as a revelation of the feelings of one of the older generation. Sir Oliver Lodge is clearly one of those who were well acquainted with "the lovable, friendly, and homely past aspects of the majority of our present foes"; and, lulled by these recollections, he failed to notice that the modern German has but little resemblance to his forefathers. Naturally the revelations of the war have shocked him, and he strives pathetically to readjust his views. He is plain-spoken in his indignation at the methods employed by the Germans in the campaign; but when he comes to the question of the settlement after the war, there appears, not too vaguely, the firm belief that madness will depart and leave us once more with the kindly Germans of his earlier recollections.

Sir Oliver Lodge's conclusions may or may not be right, and it certainly seems to be risking a good deal upon a gambler's chance. The essential condition of peace is the security of Europe for the next generation; and if the German people emerge from their ordeal in a better frame of mind it will be all to the good; but it would be criminal to leave them with their teeth undrawn merely on the chance that they might re-acquire the old characteristics which they have evidently lost. It is no use telling us that "an enormous amount of what they are committing just now has nothing to do with their soul." A nation whose soul is so aloof from "what they are committing" might just as well have no soul at all. The matter cannot be shuffled off on to the back of Prussia alone. The criminal statistics of Germany before the war were a sufficient danger signal; and, as to the South German type, the Bavarians had a bad reputation in 1870, and have gained a worse one during the present campaign. One may regret the past, in common with Sir Oliver Lodge, but it is useless to blind ourselves to the fact that we are dealing with a different kind of nation to-day.

OUR BOOKSHELF.

Soils: their Properties and Management. By Prof. T. L. Lyon, Prof. E. O. Fippin, and Prof. H. O. Buckman. Pp. xxi+764. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1915.) Price 8*s.* net.

PROF. LYON has done well to bring together his colleagues in the well-known school of soil technology at Cornell, and induce them to join in producing a book on soil management. The result is eminently successful, and will be cordially welcomed by all teachers and students of agricultural science.

Beginning with the general principles of soil formation, the authors pass, naturally, to the actual soils of the United States, and reproduce for this purpose the interesting soil map published two years ago by the Bureau of Soils. From the soil as a mass they proceed to the separate particles, dealing first with chemical and physical properties, and then with the relationships to water and temperature. Afterwards they turn to the micro-organisms of the soil, and finally to the methods of soil management—methods by which the soil conditions can be made more favourable for the growth of plants.

The distinguishing feature of the book is the extensive use made of the results of recent investigations in the United States, in this country, and on the Continent. On reading the book one is struck by the great advance made by soil investigators during the past ten or fifteen years. New points of view, new fields of knowledge, and new methods of investigation have all been opened up, and the various results are beginning to piece together remarkably well. Altogether the outlook is very hopeful, and if only soil investigators could find an elegant name for their subject they would soon be assured of an enthusiastic following. E. J. RUSSELL.

The Cures of the Diseased in Forraine Attempts of the English Nation. London, 1598. Reproduced in facsimile, with introduction and notes by C. Singer. Unpaged. (Oxford: At the Clarendon Press, 1915.) Price 1*s.* 6*d.* net.

THE short tract now published in facsimile by the Clarendon Press was written by one George Wateson, doubtless George Whetstone, the

Elizabethan playwright. Hakluyt, in the dedication to Sir Robert Cecil of the third volume of his "Voyages," refers to this tract, and says that he showed it to Dr. William Gilbert, Queen Elizabeth's physician, who found it "very defective and imperfect."

The tract is but twenty pages, on the nature, diagnosis, and treatment of some of the infections which most heavily scourged seafaring men in the tropics in Elizabeth's time—yellow fever, dysentery, erysipelas; something also on heat-stroke, prickly heat, and scurvy. We must not despise it for its brevity; it is just a tract for men in the tropics; just the beginning of "tropical medicine"; a childish thing, but commendably free from superstition and magic. The account of scurvy is vivid and practical, and the short introduction and notes by Dr. Charles Singer are admirably written and full of authority.

It is a strange feeling to have in one's hands, in facsimile, the first English treatise on tropical medicine. So many things have been discovered since 1598. It was published two years after Drake's death, at Porto Bello, of dysentery. Whetstone, in his dedication of the treatise to the Queen, says that he is writing from experience. "In my injust imprisonment in Spayne, it pleased God to afflict me with the Tabardilla Pestilence: whereof being in cure, by an especiall Physition of that King, I observed his methode for the same, and such other Diseases, as have perished your Maiestie's people in the Southerne parts."

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Organisation of Science.

I WONDER whether other readers of NATURE besides myself caught the interference fringes from three facets of this glittering subject in the issue of December 2? The first was the Royal Society's advertisement for applications for grants for scientific investigations from the Government fund; the second, the editorial contrast between the rates of pay for legal and for scientific services; and the third, the anniversary address of the president of the Royal Society, containing the suggestion that science does not take its place in the national organisation because the general public looks upon scientific investigation as a hobby.

What else can the general public do while men of science, in dealing with one another, generally act upon the principle that scientific investigation is a hobby for which facilities are required, not payment? The demonstration afforded by the Government Grant Committee and the Committee of Recommendations of the British Association is conclusive. The normal practice is for these committees to be asked to supply a portion—rarely the whole—of the expenses of some scientific investigation. The applicants in reply to the advertisement will think it meritorious to offer their brains and the time required to use them without asking for any payment. That is the true criterion of a hobby. So great is the power of science to transform serious occupations into hobbies that even lawyers sometimes find themselves astride and ambling with the rest.

In justification of the scientific societies, it may fairly be said that they were intended for the riding of hobbies, and everything in their constitution and practice conforms with that eminently useful ideal. Scientific societies rely very largely upon unpaid work, and long may they continue to do so. One of their chief attractions is that within their precincts there is a respite from the wearing obligations of debit and credit. One cannot find the like about a law court or a house of business, where as a rule those who are paid most are treated with the highest respect.

It is the difference between hobby and business that brings us to the parting of the ways. If the national scientific effort is organised through the agency of societies where all the best work, even by the officers, is done without any regard to payment, we cannot expect the public to look upon science as a business into which pecuniary considerations enter. It is, and must remain, a hobby. If, on the other hand, there should be created a Privy Council for Science, as Sir William Crookes suggests, there would be at least a permanent staff to whom the idea of paying for brains and time would not be fundamentally repugnant as it must be to the officers of a society.

The idea of scientific investigation as a hobby does not necessarily originate with the general public; it is indigenous in the older universities, where there are a large number of college officials intellectually competent to undertake researches, some of whom do and some do not. At Cambridge in my time scientific investigation was the occupation of the leisure of men whose maintenance was provided by the fees and emoluments of teaching. It was as much a hobby as chess or photography. There was no sense of collective responsibility for providing the nation with answers to its scientific questions. Scientific researches had become an element of competition for rewards of various kinds, and some "research students" were paid; but the idea of "making a living" by scientific investigation never reached the surface, though the merit acquired by research might weigh in the appointment to a post for teaching or administration. On the contrary, the early agitation for the endowment of research was regarded as finally disposed of by calling it the research of endowment, as though the wish to be paid were conclusive evidence of insincerity.

The suggested council will have some difficulty in organising adequately paid research. The endowed researcher in the national interest must expect an occasional audit of an imperious character, and his employers must see their way to act upon it. With teaching the difficulty is less. If the students of one year do not respond, the next year may be more successful. It takes just about a lifetime to satisfy ourselves about our own weaknesses. The responsibility is nicely divided; it is just as much the duty of the students to learn as of the lecturer to teach, and neither student nor teacher has the material for a considered judgment upon the matter. That is why the "hobby" system, with occasional rewards for exceptional success, is so popular. It can be worked best by letting things go their own way.

The present state of things, which all agree in deploring, can be altered by drawing a clear distinction between a society's hobbies and the nation's purposes, and entrusting them to separate administrative management. Mr. Carnegie has made it clear that the financial detachment of a voluntary society is not essential to the successful organisation of scientific research.

F.R.S.

NOTES ON STELLAR CLASSIFICATION.

The Temperature Curve.

IN the first article under this title—NATURE (November 12, 1914), and Bulletin 1 of the Hill Observatory—I referred specially to the temperature curve, and pointed out that "to secure simplicity I represented the two arms of equal inclination," and to save space I used a narrow angle between them. I went on to add that by all analogy the descending arm should fall less rapidly than the ascending one rose. The analogies to which I referred dealt with the well-known curves representing the various changes in the light of new stars and of such variable stars as Eta Aquilæ, to deal with one the light curve of which has been previously given in these notes.

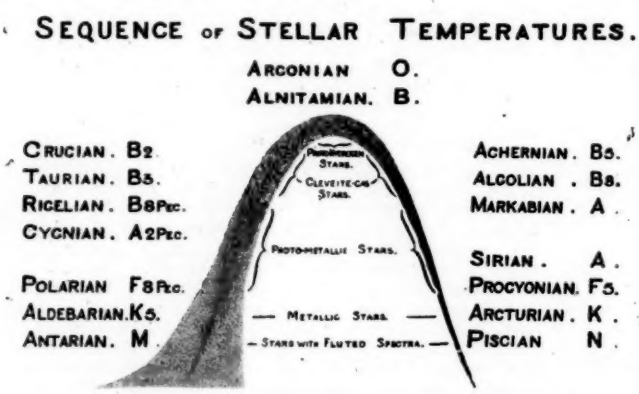


FIG. 1.—The difference in the two arms of temperature curve.

The only differences in the two arms I felt myself justified in showing were the nebulous condition in the ascending arm and the condensed condition in the descending one.

On my hypothesis the life of a star consists first as an increase of temperature due to collisions in a condensing nebula; then, after the apex of temperature has been reached, the gradual cooling down of a mass of gas and vapour.

If we can deal with a large number of stars, the true outline of a generalised temperature curve should be placed before us in considering the numbers of stars of the various groups, because the longer a star remained at about the same temperature the larger would be the number of stars in that group; and if the rise of temperature were very rapid, this would be indicated by a considerable reduction in the numbers.

My recent publication of a catalogue of the spectra of 354 of the fainter stars, combined with my previous catalogue of 470 of the brighter ones, has enabled me to test this method of inquiry.

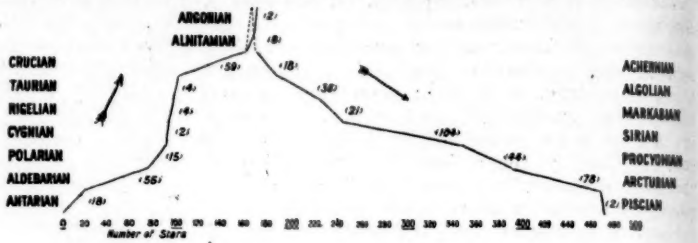


FIG. 2.—Temperature Curve based on the number of stars in each spectral group in the catalogue of 470 brighter stars.

Although the number of stars in each catalogue is comparatively small, it is perhaps large enough to average the results fairly; and as we can deal with two catalogues based on the same scheme of classification under as nearly equal conditions as possible, the comparison of the results obtained in both cases should show us, if they are similar, that the base of inquiry is a firm one; and if minor departures from similarity arise between the results obtained from the brighter and the fainter stars, we may be enabled to gather some important conclusions from the similarities or dissimilarities of the two curves. The illustrations given show how far this inquiry has already gone. In Fig. 2 the numbers of stars in each group of the 470 brighter ones are indicated by the figures shown opposite each group, on a base line the length of which is determined by the numbers of stars. In Fig. 3 the same process is followed in the case of the fainter stars, the length of the base line equally representing the number of stars dealt with.

FIG. 3.—Temperature Curve based on the number of stars in each spectral group from the list in Bulletin III. Numbers in brackets show the number of stars in the separate group.

It will be seen that there is a very general likeness between the curves of the brighter and fainter stars, and to bring this out more clearly

in the fourth diagram I have brought the observations to the same scale by dealing with percentages instead of the actual number of stars as a base line. In both cases it will be seen that the shape of the curve is in harmony with the analogy to which I referred, and I think I am justified in adding that since the curves are so similar, although they have been obtained from such different sources, not only is the method of inquiry amply justified, but the principles on which the stars have been classified and separated into the various ascending and descending groups are shown to be fundamentally sound. This, of course, goes to strengthen my main contention that the life-history of a star is a rise, followed by a fall, of temperature.

Further inquiries are necessary before all the conclusions to be drawn from a comparison of the two curves can be arrived at, but some are already suggested

One point on which information might be expected from the method under notice is an indication of the various maximum temperatures attained by the individual stars. If all the stars reached the highest temperature we should expect a broader apex in the average result than if the number were restricted. A first glance at the composite curve shows that the number at the highest temperature is very much restricted. We are justified, therefore, in suggesting that those groups containing a relatively larger number of stars represent the highest temperature condition of a larger number. On the other hand, the nearly perpendicular part of the curve in the middle of the ascending side as contrasted with the slowly descending curve on the descending side indicates the action of a rapidly increasing temperature in the former. The kinks in the ascending curve, therefore, at the Aldebarian and Crucian stages of both groups of stars possess great interest from these points of view.

When a larger number of stars have been classified, and further evidence is afforded that we are absolutely dealing with homogeneous groups, this average temperature curve may help us in the study of masses and densities. We should expect, for instance, that the probable inclusion of solid meteorites in stars classified in the lower part of the ascending curve give rise, in some cases, to large masses, while on the opposite side of the curve we should expect densities above the normal.

Since my classification is based upon absorption phenomena, the curves do not include the stars in which bright lines alone have been studied, but I am continuing my inquiries concerning them, and it looks as if they will ultimately be found to represent special classes of nebulæ—that is, swarms in which something besides an ordinary condensation is taking place.

I have already shown (NATURE, February 4, 1915, and 2nd Bulletin of the Hill Observatory) that the stars with constant bright lines added to absorption phenomena occur near the top of the temperature curve.

I have to thank Mr. H. E. Goodson, A.R.C.Sc., assistant at the Hill Observatory, for the preparation of the curves. NORMAN LOCKYER.

FIG. 4.—Temperature Curves based on the percentages of stars in the separate groups in "Bulletin III. and "470 Catalogue."

Stars in "Catalogue of 470 Brighter Stars."
Stars in list in "Bulletin III."

A PLIOCENE FLOTSAM.[1]

BOTANISTS expect from the authors of this instalment of the results of their sustained investigation of the Pliocene vegetable deposits of the delta of the Rhine, then much more extensive than now, work of a high standard. Those who may be led to study the work before us will find that this standard has been fully sustained, and will be left in doubt whether to admire most the care and patience in the examination and arrangement of their material to which the text and the plates which illustrate it bear testimony, the clearness with which their evidence is tabulated, or the caution and restraint with which their conclusions are formulated.

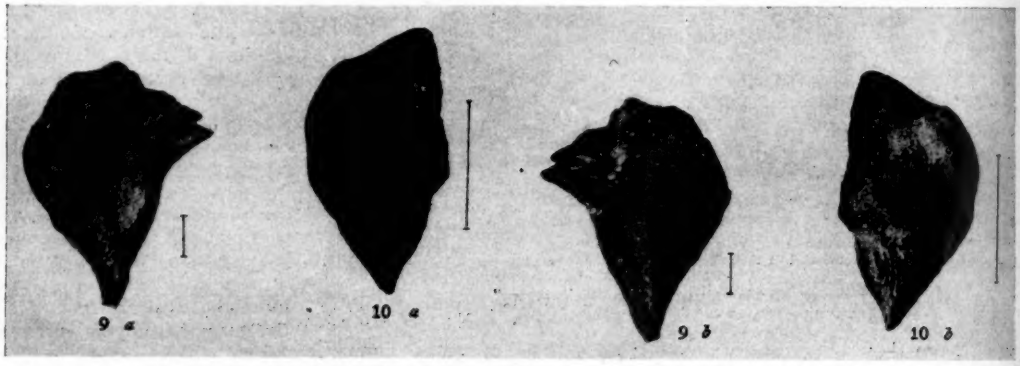
We are already indebted to our authors for various contributions to our knowledge of similar deposits associated with the brick-earth of Tegelen on the Meuse, and in that case they have been able to show from other evidence that the deposits in question are, at least approximately, contemporary with the Norwich Crag, and perhaps in part with the somewhat more recent forest-bed of Cromer. The present instalment deals with material from an older horizon, belonging to the middle, not the upper Pliocene, obtained from brick-clay pits near Reuver and Swalmen, and some distance further south at Brunssum, and the circumstance that, owing to the lack of collateral evidence, it is impossible yet to suggest a corresponding formation west of the North Sea, in no way detracts from the interest which their results arouse.

1 "Mededellingen van de Rijksopsporing van delfstoffen." No. 6. "The Pliocene Floras of the Dutch-Prussian Border." By Clement Reid and Eleanor M. Reid. Pp. 173+xx plates. (The Hague: Institute for the Geological Exploration of the Netherlands, 1915.)

A careful examination of this paper by those familiar with the physical features of a deltaic country, such as Bengal, will induce the conclusion that the conditions under which the deposits discussed in it with such critical insight were accumulated, must have resembled those which prevail there now. Behind the alluvial "shoot" which forms the seaward edge of the delta the partially subaerial tract is broken by a network of distributaries into many low islands, the margins of which, being river-banks, rise slightly above the land within. Towards the sea these islands are stretches of mud partially clothed with salt-scrub or mangrove, or of sand with a fringing sea-fence of screw-pine and other beach-plants. Further back the mangrove swamp merges into a littoral forest, which extends as far as the tides flow salt, and clothes the islands throughout. Still further inland, where the rivers when in flood are not saline, their banks alone carry forest, the lower ground behind making a stretch of marsh when the streams are low, fresh-water lagoons when they run full.

From these arises an extension of the riparian forest, just as from the jetsam of the sea-face come the beach-fence and the flora of the mud-flats.

The flotsam has another and more varied fate. Much of it reaches the sea, to be swept by shore currents into a mass, many square miles in extent, sufficiently compact to impede the course of sea-going steamers, which accordingly avoid it. Before becoming so water-logged as to sink, most of this flotsam undergoes disintegration. Much, however, when the streams are full, is floated beyond the river-banks into the lower land behind. Within the area where the lagoons are emptied at every tide many of the fruits and seeds, arrested while fresh, germinate and help to clothe with forest the surface of the islands involved. But throughout the more inland area, where the flooded streams pond back their overflows for nearly half the year, such fruits and seeds as pass beyond the banks float on the surface of the lagoons among their water-weeds, to be deposited, their vitality lost, in the mud of the marsh which remains when the streams subside. The ensuing flood overlays



9 *a*, *b*, *Hakea angulata*. Follicle, inside and outside. 6/1 Brunssum. 10 *a*, *b*, *Hakea saligna*. Follicle inside and outside. 2/1 Recent. From "The Pliocene Floras of the Dutch-Prussian Borde."

The contour of these islands constantly alters. The heavy flow in the larger channels may erode the shore on which the current impinges. The bank may be breached, the stream change its course, an island be cut in half, and only a line of mortlakes and marshes be left to mark the abandoned river-bed. More often, however, the root-system of the riparian vegetation keeps the bank unbroken, and the current only undermines. At flood-fall the sapped bank, deprived of the support which the water-pressure supplies, may sink into the channel, its coat of forest still intact. Submersion during the next flood-season kills the half-drowned trees. But they remain as a groin-like obstruction which deflects the current and induces a similar attack on the opposite bank further down stream. Coincident with such erosion is a compensating shelving accretion on the eddy-side of the eroded reach. Such newly-formed banks become clothed with grass and sedge which protect the surface, arrest silt, and become littered with a jetsam of fruits and seeds.

them with silt and converts them into an organic deltaic deposit.

That the Reuverian one here described may have been the flotsam of such a fresh-water marsh-lagoon seems probable from several circumstances. There is nothing littoral in its composition, and the species which go to compose it, other than those like Nelumbium, Euryale, Trapa, Cladium, Dulichium, which were probably denizens of the actual site, may conceivably have grown on the higher ground between the lagoon and the stream, or have been water-borne from the uplands of the catchment areas of the rivers concerned. As in the Gangetic delta fruits and seeds are found west of the Baleshwar which can only have come from Upper India, east of that channel which must have come from Assam, so in the Reuverian deposits a difference is perceptible in the constituents where only the Meuse can have been involved, as compared with those laid down below the confluence of that stream with the Rhine.

One feature of our authors' results is their corroboration from different data of those obtained by Sir Joseph Hooker regarding the distribution of Arctic plants. Study of large genera widely distributed in the northern hemisphere suggests that during the latest southward flow distinct routes of migration were followed. The flora of the Reuverian horizon which antedated the precedent northward flow shows, as might be expected, an intermixture of elements characteristic of what are now somewhat specialised floras. One instance of this is illustrated by the figures from Plate VI. here reproduced. The figures 9 *a*, *b* show a fruit which our authors refer to the genus Hakea, the family of which is no longer European, alongside those of an existing Australian species, figured in 10 *a*, *b*. Another curious point is brought out by these figures. In a noticeable number of these Reuverian plants the carpels or seeds are considerably smaller than in existing species of the same genera. Besides Hakea may be mentioned Alisma, Bucklandia, Epipremnum, Liriodendron, Mimusops, Nelumbium, Trapa, Zelkowa, and the list might be extended.

Those who have had to identify, in the jetsam of a tropical sea-beach, the seeds and fruits of species growing close at hand, can understand better than others the difficulties our authors must have experienced in dealing with material in every stage of decay, due to submersion and dissolution caused by pressure. But even these can only dimly appreciate the labour involved in identifying material yielded by species which no longer exist, with no better help than the all too inadequate carpological collections of even the best European herbaria can afford.

More than a passing acknowledgment is due to the care with which this work in a foreign speech has been printed for the Netherlands Institute for Geological Exploration. There are very few of the slips which seem inevitable under such conditions. "Tot" for "to," "al" for "all," "ot" for "or" do indeed occur, but the only one which calls for correction, in addition to those indicated in the errata at the end of the text, is "exerted" for "exserted" on p. 78.

NATIONAL ECONOMY IN FUEL.

THE need for economy in our national life has been urged upon us in the most emphatic manner by his Majesty's ministers and others, and there can be no doubt but that, great as efforts to economise may have been in recent months, still greater efforts must be made in the immediate future. From the national point of view there can be no greater need than for the most rigorous economy in the utilisation of our coal supplies. The appointment of a committee by the British Association, as announced in NATURE of October 21, shows a timely appreciation of the necessity for, and a desire to do everything within the powers of the association to achieve, economy in this direction.

The question is not a new one. It was considered exhaustively in the report to the Royal Commission on Coal Supplies, 1901–1905, and many eminent men have directed attention to it. Sir William Ramsay dealt with the subject some few years since in his presidential address to the British Association, and advocated the formation of an annual stocktaking commission. More recently, at Cardiff, Prof. H. E. Armstrong emphasised the necessity for more scientific methods, and a committee was formed to deal with points of benefit to local industries, which would necessarily include coal. But hitherto the question has been treated mainly from the point of view of exhaustion of our supplies, and it cannot be claimed to have attained any great success. On the whole, waste in production and most uneconomical utilisation still persist.

As Mr. Lloyd George has said, "in peace and in war King Coal is the paramount lord of industry." The demand for coal has not been lessened by the war; rather do we find it largely increased by reason of the enormous demands for the output of war material. In Sheffield it has been stated that the consumption of gas for power and heating purposes is ten times greater than before the war. In Birmingham the demand was 13·5 per cent. greater in the past six months than in the corresponding period of last year. Similarly, the demand for electric power is affecting numbers of towns. In addition, the large requirements of our Allies must not be overlooked.

In 1913 the coal output was 287,411,869 tons and the number of employees 1,110,884. Owing to the great response of the miners to their country's call, Mr. Asquith estimated the output as reduced by 12 per cent. or 34½ million tons below the normal. Clearly at no time in our history has need for economy in coal been so absolutely essential.

The reduction in output and the difficulties of transport have been brought home forcibly to the individual by the big rise in prices. Hitherto the realisation of the need for economy has been confined to the few, and therefore been largely futile. The more general recognition of this need is the best augury for the success of the committee's efforts, as far more likely to result in Government action.

Whilst the open fireplace, responsible for so much waste, still retains its popularity, consumers may be trusted to exercise greater personal care with coal at its present prices than in the past; but the undoubted extension which will take place in the utilisation of gas for heating and cooking, and of coke in the grate, will ensure far more efficient utilisation of coal. Further, the householder can, at this juncture, be brought to realise how essential to the supply of the munitions of war the by-products of the gas industry are; products he sends to waste up the chimney.

In production every waste must be avoided and the output per head of the mining population largely augmented, although this will at once bring its attendant troubles over hours of labour.

In America the output is higher than in this country, a result ascribed to the more general use of improved cutting machinery and the greater capacity of mine tubs. But naturally economies at the pit will, to a considerable extent, have to wait, the whole energy of the management being concentrated on increased output in face of shortage of skilled labour. In the utilisation of coal for power and industrial heating we have been extravagantly wasteful in the past, but of recent years there has been a marked improvement through the introduction of more efficient power-generating plant. In the case of steam, the higher efficiency of engines, and particularly the introduction of the turbine, has lowered fuel consumption per horse-power. The extended use of power-gas plants has given a very low cost of fuel for both power and heating purposes, and enabled poor-class coal to be employed efficiently and valuable by-products to be recovered. Much improvement may still be effected through further developments in these directions, and particularly in the more scientific control of methods of combustion and gasification by trained fuel specialists.

In connection with the metallurgical uses of coal, it is impossible to compute the amount of waste in the past by the coking of coal in the old type bee-hive oven, in which no inconsiderable proportion of our coke is still produced, and as long as one of these ovens is in use, unnecessary waste is being entailed. There has fortunately been a steady increase in the introduction of by-product recovery ovens, and about two-thirds of the total coal carbonised for metallurgical coke (more than 20 million tons) is treated in recovery plant. When the valuable by-products, which include benzene and toluene—so much in demand for the production of high explosives—and sulphate of ammonia are considered, it is obvious that any coal carbonised in non-recovery plant leads to absolute waste of valuable materials, in addition to a prodigal waste of heat units. Prof. W. A. Bone, in addressing the Chemistry Section at the meeting of the British Association in September, suggested that, in the public interest, the Government might fix by law a reasonable time-limit beyond which no bee-hive coke-oven installation should be allowed to remain in operation.

The present writer, several years ago, in a lecture on fuel economy, urged the necessity of a comprehensive study of our coal supplies in order to afford systematic information as to the suitability of the different seams for various industrial purposes, as being essential to the most efficient use of our supplies, and advocated the establishment of a Government fuel-testing laboratory on the lines of the United States Bureau of Mines laboratory. Prof. Bone, in the address referred to, suggested a memorial to the Government for the establishment of a similar central organisation. It may be that at present difficulties in the provision of funds for this purpose would be great, but there can be no doubt of a very adequate return for the outlay, and if the committee appointed by the British Association can secure a sympathetic consideration of this question, it will have done an incalculable service to the community and have fully justified its existence, independently of the other fields in which its activities will find scope. J. S. S. BRAME.

AGRICULTURAL EDUCATION AND RESEARCH.[1]

WE open the latest report on Grants for Agricultural Education and Research wondering how the war is going to affect the liberal policy adopted in recent years by the Board of Agriculture. It is satisfactory to find that the Board means to continue on the high plane on which it started: economies there will have to be, but the main lines are, for the present at least, to continue as before.

Perhaps the most important change during the year has been the framing of new regulations for the distribution of grants for agricultural education and research. Hitherto the grants have been paid in several different ways; in future there is to be more uniformity of procedure. When Government aid was first given to agriculture in the form of "whisky money," it was left to the local authorities to decide how they would spend the money. Some simply used it as a dole to the farmer and applied it towards the relief of the rates; others set up local schools; others, again, realising the need for higher work, set up colleges and aimed at having scientific investigations carried out.

This diversity of aim on the part of the local authorities was accompanied by equal diversity of procedure on the part of the Board, and the schemes were aided on four different plans, viz., by block grants made to colleges, by farm institute grants paid on a partnership basis, by grants representing the agricultural shares of block grants previously paid by the Board of Education, and by grants in aid of particular schools and classes based on the number of pupils and hours of attendance. By skilful management, an astute county council clerk could manage to draw the bulk of the money out of the State, basing the claim for gants on expenditure which was really being met by "whisky money." The more progressive counties, on the other hand, were hit rather hard, and substantial expenditure by the ratepayers drew little or no assistance from the State, because it was disqualified for some technical reason quite unconnected with the value of the work itself.

It is gratifying to know that all this is now being taken in hand, and a scheme has been evolved for dealing with the matter. The main trouble is, of course, that the taxpayer has parted with his control over the "whisky money," and the local authorities can do with it what they think fit. The Board's scheme has therefore to be attractive, or the backward counties will have

[1] Annual Report on the distribution of Grants for Agricultural Education and Research in the Year 1914-15.

nothing to do with it. Briefly, the essence of the scheme is to secure an effective partnership between the State and the local authority for furthering agricultural education. Each scheme has to be considered as a whole and estimates planned before it is put into operation; then the cost is to be divided between taxpayer and ratepayer on an approved scale.

The effect of the partnership will be more than financial; it is by no means intended that the State shall be the sleeping and paying partner. The agricultural resources of the country have got to be developed to the fullest extent, and this is no time for allowing any backward county council to block the way.

As might have been expected, the war has had a serious effect on the agricultural colleges and research institutes. The best of their young men volunteered at once for military service. Some of the colleges were practically emptied, and the research institutes lost their most vigorous and enterprising workers, some, alas! never to return. But, to the credit of the Board, the principle that education and research must be kept going has so far been successfully maintained, and although the grants are rightly reduced automatically as members of the staff enlist, there is no evidence from the report that any of the institutes have suffered financially. In return, it is satisfactory that the Board is able to record that the research institutes and colleges have rendered valuable help in dealing with the special problems arising out of the war. It never was more necessary than now that farmers should have the best expert advice available, and it is gratifying to know that all concerned are doing their utmost to help in the emergency. Research institutes subsidised by Government are new things to the ordinary taxpayer, and a great responsibility devolves on them to justify themselves in the present emergency. If science can help agriculture, surely this is the time for doing so.

SIR HENRY ROSCOE, F.R.S.

BY the death of the Rt. Hon. Sir Henry Enfield Roscoe, through heart-failure, on December 18, at his residence, Woodcote Lodge, West Horsley, we lose one more of that rapidly dwindling body of men of whom Huxley may be said to be the type and leader, who spent their energies, after the passing of the Education Act of 1870, and largely in consequence of it, in attempting to rouse this country to a sense of the national importance of secondary and technical education. Except for occasional trouble with gout, and the slight infirmities of advanced age, he was in his usual state of good health and happy serenity of mind up to within the very hour of his seizure. It was such a passing as he would himself have desired; a swift and painless ending to a long, strenuous, and honourable career.

As he tells us in his "Life and Experiences," an autobiographical record which he published in 1906, with the characteristic motto on its title-page, from Carlyle's "Sartor Resartus,"

> What is the use of health,
> Of life, if not to do some
> Work therewith?

he first saw the light at 10 Powis Place, off Great Ormond Street, London, on January 7, 1833. His father, Henry Roscoe, was a barrister, and became Judge of the Court of Passage in Liverpool; his "Digest" was for many years a standard work of reference. Roscoe's grandfather, William Roscoe, was a still more remarkable man, who from very humble beginnings raised himself to a position of affluence, and of considerable influence in his native town. He represented Liverpool for a session in the Parliament of 1806 as an advanced Liberal, but in 1816 lost his fortune by the failure of a bank in which he was a partner. He left his mark on our literature by his "Lives of Lorenzo di Medici and Leo X." He also made occasional contributions on botanical subjects to the Linnean Society.

Roscoe's mother was a Miss Fletcher, the daughter of a Liverpool merchant, who also lost his money by the failure of a bank. She was a highly capable woman, of great force of character, and lived to a green old age. She had considerable artistic gifts, and on the death of her husband after five years of married life, when she was left with very straitened means, she gave lessons in painting. She had, too, literary ability, and when well advanced in years published a life of "Vittoria Colonna," with admirable translations of the sonnets. Roscoe's forbears on both sides were of Presbyterian or Unitarian stock, his great-grandfather on the mother's side being Dr. Enfield, a colleague of Priestley in the Warrington Academy, and the author of the once well-known "Enfield's Speaker."

After a few years at a preparatory school Roscoe was sent to the High School of the Liverpool Institute, where he had little Latin and less Greek, but, what was remarkable in those days, a certain modicum of science. His teacher of chemistry was Balmain, the discoverer of "luminous paint" and of boron nitride, a genial and capable instructor, from whom he seems to have acquired his taste for the science. At all events he now started experimenting on his own account, and began his career as a lecturer by giving demonstrations to his sister, his cousins, and, no doubt, also his aunts, at a charge of one halfpenny each person, to defray the cost of the chemicals—the summit of his ambition at that time being, as he said, to "burn phosphorus in oxygen on a large scale before an admiring audience."

The attitude of the older universities towards Dissenters at this period caused Roscoe to be sent to University College, London, which he entered in 1848 with a view to preparing for a degree of the University of London. Here he came under the influence of Graham, at that time professor of chemistry, and afterwards of Williamson, who succeeded him. He took his degree in 1853, and decided to follow chemistry as a profession.

He had acted for a short time as Williamson's private assistant, and had helped him in the experimental illustration of his lectures. Williamson was then in the heyday of his activity. It was the beginning of a new epoch, which was destined to have a profound influence on the development of chemistry, theoretical and practical—a movement in which Williamson was a pioneer, and Gerhardt, Laurent, Hofmann, and Kekulé were active agents. It is perhaps idle to speculate what would have been the course of Roscoe's career had he remained at University College in association with Williamson. In mental habitudes the men had not much in common. Roscoe at no time had any active sympathy with the philosophical side of chemistry, and chemical speculation had few attractions for him. His mind was essentially practical, and hence the achievements of determinative chemistry were what he chiefly valued. He probably, therefore, did wisely in going to Heidelberg, for he found in Bunsen a type of mind like his own, and a worker with whom he was in complete accord, and their acquaintance soon ripened into a friendship which ended only with Bunsen's death. How completely the two were in sympathy may be seen in Roscoe's admirable memorial lecture on Bunsen which he gave to the Chemical Society, and it is reflected no less clearly in the pages of his autobiography.

Roscoe's life in Heidelberg and his intimate association with Bunsen brought him into close contact with all that was worthiest in German university life, and he contracted firm friendships with many of the most eminent men of that period—the two Roses, Magnus, Kirchhoff, Helmholtz, Kopp, Koenigsberger, Quincke, and others. He always looked back upon this time as one of the happiest memories of his life. He had to the last a very tender regard for what is best in the German character as it was revealed to him in the many friends he learned to know and to love at this period. He viewed with increasing anxiety and regret the growth of the strained relations between the governing powers in Germany and this country, and his last literary efforts were directed, so far as it was possible to him, to mitigate them. "It would be an outrage to civilisation," he wrote, "if two countries so closely allied in blood and intellectual development should ever come to blows." And when the rupture did come it clouded the few remaining months of his life.

Roscoe's first and only professorship was at Owens College, Manchester, to which he was elected in 1857 as successor to the late Sir Edward Frankland. At that time it was the day of small things with the College. As an institution it was looked at somewhat askance by reason of the terms of its founder's intentions in regard to religious tests and instruction. It was inadequately endowed, and poorly housed in a building of which the only claim to distinction was that it was formerly the residence of Richard Cobden. Fortunately it was staffed by an exceptionally able body of young and enthusiastic teachers, limited in number but united in their determination to keep the lamp of learning alight in the squalid and benighted regions of Deansgate. This is not the place, even if space permitted, to dwell upon the progress and development of Owens College, or to show how it grew eventually into the University of Manchester. During the thirty years of his connection with the institution Roscoe took a leading part in stimulating and fostering this development, and before he severed his connection with it as an active teacher he had the gratification of seeing it attain to full university honours. To this success his efforts in erecting a school of chemistry in no small degree contributed. He made its chemical laboratories famous throughout the world, and at one time or another students from nearly every civilised country were to be found working within its walls. This result was due not so much to Roscoe's influence as a leader in chemical inquiry; students were not attracted as in a German university, solely by the fame of the professor's researches; they came, in the first instance, on account of the thoroughness and comprehensiveness of the instruction; they remained because of the stimulating effect of the atmosphere of research into which they were eventually led.

The scheme of instruction which Roscoe introduced was essentially that at Heidelberg, and he followed Bunsen's methods and example. His success as a teacher was largely owing to his energy, his power of organisation and business aptitudes, his judgment of men and capacity for getting the best out of them. He was not what could be termed a brilliant lecturer; he had nothing, for instance, of the fire and enthusiasm of Hofmann; but his language was simple, direct, and to the point, with not the least pretension to rhetorical effect, in all of which, as in other respects, he resembled Bunsen. Like Bunsen, too, he took considerable pains in the experimental illustration of his teaching; in this he was assisted by a skilful and ingenious collaborator, Heywood, well known to Owens College men of a generation or so ago. How affectionately Roscoe was regarded by his students, and how gratefully they recalled their obligations to him, may be seen from the terms of the address, signed by three hundred of them, which they presented to him on the occasion of his jubilee as a doctor of philosophy of the University of Heidelberg. It may be seen, too, in their gift of his portrait by Herkomer to the late Lady Roscoe on his retirement from his professorship, and in the presentation of his bust by Mr. Drury to the Chemical Society on the attainment of his eightieth birthday.

The volume of Roscoe's original work in chemical inquiry when compared with the output of many of his contemporaries, especially on the Continent, cannot be considered large. His most important investigations were his photochemical researches, partly done in concert with Bunsen, and his work on the chemistry of vanadium. His first memoir on the latter subject was made the

Bakerian lecture of 1868, and the value of both was further recognised by the Royal Society by the subsequent award to him of a Royal Medal.

Other important work which has long since taken its due place in the literature of the science is his observations on the constitution of aqueous solutions of acids and his investigation on perchloric acid and its compounds.

Roscoe did a notable service to science by his action in making Bunsen and Kirchhoff's work on spectroscopy generally known in this country, and during the early 'sixties there were few of our larger towns in which he did not demonstrate by means of popular lectures the astonishingly interesting results of the then novel form of chemical analysis. His first lectures on the subject in London were republished in collected form, suitably illustrated, and the book had a considerable success and passed through several editions. He made, in addition, a number of original spectroscopic inquiries, the results of which appear in the publications of the Royal Society.

But the work by which he will continue to be known is the service he rendered to teaching by his many manuals of instruction, some of which were highly popular, ran through many editions, and were translated into a variety of languages. Of these the most important is the large treatise in which he co-operated with his former assistant and friend, Carl Schorlemmer, the first professor of organic chemistry in this country, a man of great erudition, and an able and well-informed chemist. No combination of workers could be more happily selected, for each, in a sense, was complementary to the other. Schorlemmer was the bibliographer, with quite a remarkable knowledge of chemical literature and an extraordinarily retentive and accurate memory, whilst Roscoe's gift of exposition and faculty of clear and simple statement and of systematic arrangement enabled all the accumulated wealth of facts to be set forth in an eminently attractive and readable form.

This appreciation is concerned more particularly with Roscoe as a teacher engaged in the pursuit of experimental inquiry, with which aspects of his career the writer may claim to have some right to speak from personal knowledge. It must be left to others to deal with his many other activities during the later years of his life, such as his political life, his work in regard to technical education, and in connection with the still unsolved problem of the true function of a great metropolitan university, and the important services he rendered to preventive medicine in his association with the Lister Institute. T. E. THORPE.

NOTES.

SIR ARCHIBALD GEIKIE, O.M., K.C.B., F.R.S., will reach his eightieth birthday next Tuesday, December 28. He is in excellent health, and still busy with his pen.

WE announce with much regret the death on December 17, at seventy-five years of age, of Sir John Rhys, principal of Jesus College, Oxford, and professor of Celtic in the University. In addition to his other titles to distinction, Sir John Rhys was well known for his work in archæology and anthropology. He was president of the Anthropological Section of the British Association in 1900.

LORD ALVERSTONE, late Lord Chief Justice of England, whose death occurred on December 15, was a fellow of the Royal Society, having been elected in 1902 under a statutory provision, formerly in operation, which allowed of the election of Privy Councillors. He was a familiar figure at the society's annual soirées, and from time to time attended and spoke at the presidential anniversary banquets. Lord Alverstone had a long and traditional connection with the Royal Society of Arts, the son in this respect continuing the highly useful services rendered by his father, Mr. Thomas Webster, Q.C. Elected on the council in 1883, he was chairman of that body from 1890 to 1894, remaining afterwards an ordinary member of council for a long period of years. On King George's accession to the throne in 1910, the presidency of the society became, thereby, vacant, and the late Lord Chief Justice accepted the post. He resigned in 1911 in order to make way for his Royal Highness the Duke of Connaught. It may be recalled that Lord Alverstone opened the proceedings of the "Law, Political Economy, and Legislation Affecting Chemical Industry" Section of the International Congress of Applied Chemistry, held at South Kensington in 1909, giving a thoughtful address on the right method of legislating upon and dealing with scientific technical knowledge.

THE letters in the *Times* during the last few days from Mr. C. H. L. Alder, Sir William Ramsay, and Mr. J. A. Goudge again direct attention to a remarkable state of affairs. As recently pointed out in NATURE, Germany is necessarily suffering from a serious shortage of fats, and consequently of glycerine, which is obtainable from no other source. Notwithstanding our supposed blockade, Germany is making up for this shortage by the import, through neutral countries, of fats and oil-containing seeds. Though primarily produced abroad, the fatty materials to a large extent pass through British hands and British ports. In the correspondence referred to, disturbing statistics are given concerning linseed, which is one fatty material out of many. Sir William Ramsay shows by a simple calculation that from linseed oil alone our Government has furnished the enemy with no fewer than 18,000 tons of gun ammunition. Actually the position is much worse, and the additional complication is now arising that, owing in part to the general dislocation of transport, there is more than a possibility of a future shortage of fatty materials, and consequently of glycerine, in this country. The price of fats here is rising in an alarming manner, though since their cost is still small compared with that ruling in Germany, the financial temptations to export to neutral countries bordering on Germany remain immense. It is difficult to understand whether the present policy of the Government is due to want of knowledge or to reasons of high

politics; if the former, we may justly ask what are the Government chemists and the scientific Advisory Committees doing to enlighten responsible authorities on this matter?

THE death is announced of two ex-directors-general of Indian Telegraphs. Mr. J. Horsburgh Lane, who was deputy-director-general in 1890, and officiating director-general in 1892, retired in 1894. He was the compiler of a "Word Code for Foreign Telegrams," and at the time of his death had reached the age of seventy-six years. The other Indian Telegraph Department official who has just died was Mr. F. Gurr Maclean, who was director-general from 1900 to 1903, when he retired. He died at Woking, aged sixty-seven years.

THE Government has decided that all medical students, except those in the two last years of professional study, are to relinquish their work and become combatant members of the Army. While it must be recognised that the interests of the community must be subservient to the military needs of the State, the heavy drains now being made on the medical reserves of the nation may well in the future bring about an acute shortage of medical men. As the *Morning Post* pertinently asks: What is going to happen if the war is prolonged, and few new medical men become available in the future? For under the present policy, after the end of 1916, no present students will become qualified except a few medically unfit for the Army. Altogether probably not more than 600 or 700 men are involved—a negligible contribution to the fighting forces of the Army—but a number which in four or five years' time would be of the greatest value in augmenting the then depleted medical service of the country. We are already suffering from a diminished birth-rate, an increasing death-rate, and an increased infant death-rate, and if the medical care of the community be lessened, as it inevitably will be if there are no fresh doctors, these evils will certainly increase. If these students could be made use of as dressers and attendants, and the time so occupied were allowed to count towards the time required for the medical curriculum, the difficulty would be partly met. The first and second year students should at least be relegated to so late a class in the reserved groups that their calling up will occur only in the case of the most desperate need.

DR. ORVILLE A. DERBY, whose death at Rio de Janeiro we reported last week, was one of the most active pioneers in the geology of Brazil, and did great service to science by the influence he was able to exert on the Brazilian Government. A pupil of Prof. C. F. Hartt, of Cornell University, whose well-known "Geology and Physical Geography of Brazil" was published in 1870, he followed in his teacher's footsteps, and in 1879 was appointed director of the Geographical and Geological Commission of the State of San Paulo. In 1906 he removed to Rio de Janeiro as director of the newly instituted Geological and Mineralogical Service of Brazil, and there remained full of activity until his last brief illness. Dr. Derby's first original paper was a notice of some Palæozoic fossils collected by A. Agassiz and S. W. Garman near Lake Titicaca, in 1876; and in the two following years he published in the Archives of the National Museum of Rio de Janeiro important memoirs on the geology of the Lower Amazons and the neighbourhood of Bahia. In 1878 he also described the diamond-bearing region of Paraná, and in later years most of his researches were concerned with petrology and the distribution of the sources of the rarer minerals. To the end, however, he was interested in the purely scientific aspect of his work, and one of his last papers was on the microscopical structure of the Permo-Carboniferous fern-stem, *Psaronius brasiliensis*. He was ever ready to welcome and help other geologists who visited the country for special purposes, and in 1906 he co-operated with Prof. J. C. Branner, of Leland Stanford University, in producing a useful manual of elementary geology adapted for Brazilian students. Dr. Derby became a fellow of the Geological Society of London in 1884, and was awarded the Wollaston Donation Fund in 1892.

THE juvenile lectures of the Royal Society of Arts will be delivered by Prof. J. M. Thomson and Mr. J. Swinburne. Prof. Thomson will give the first lecture on January 5, his subject being "Crystallisation," and Mr. James Swinburne will give the second on January 12, upon "Science of Some Toys." Both lectures will be fully illustrated with experiments.

WE have received from Mr. F. W. FitzSimons, of the Port Elizabeth Museum, an abstract of his paper on the fossil human skull from Boskop (Transvaal), read before the meeting of the South African Association at Pretoria. It is essentially identical with his letter on the subject published in NATURE of August 15, 1915 (vol. xcv., p. 615), and indicates clearly that, although he emphasised the high state of mineralisation of the fossil, he had no intention of referring it to so remote a period as that of the Karoo reptiles.

THE President of the Board of Agriculture and Fisheries has appointed a Committee for the purpose of making such arrangements as are likely to ensure the fullest use being made of native resources in supplying existing demands for timber. The Committee is prepared to purchase standing timber and to make arrangements where necessary for felling, hauling, and conversion. All communications for the Committee should be addressed to the Secretary, Home Grown Timber Committee, Craven House, Northumberland Avenue, W.C.

ON Sunday evening, December 19, a great fall of chalk took place on the cliffs which overlook the picturesque Warren, near Folkestone, and it is reported that a considerable amount of damage has resulted. The South-Eastern Railway line, which runs along the foot of the cliffs, has been buried for a considerable distance under the débris, whilst the main road between Folkestone and Dover near the edge of the cliff exhibits long cracks about 4 in. wide, and heavy traffic has been stopped. Fortunately, no lives were lost, and although a house built only a few years ago on the face of the cliff was involved in the fall, the

occupants luckily escaped. The fall is undoubtedly due to the recent spell of wet weather, and the explanation is simple. At this point the chalk dips inland at a low angle, but the various joint-planes which traverse the bedding at right angles emerge in the face of the cliff. The enlargement of these joints by the percolation of water weakens the overlying mass of chalk, which finally slips forward, and its detachment gives rise to the fan-shaped scar so characteristic of the cliffs in east Kent.

ON and after January 1, 1916, the following fees will be charged, in the interests of national economy, for admission to the Royal Botanic Gardens, Kew:—On Mondays, Wednesdays, Thursdays, Saturdays, Sundays, and Good Friday, 1*d.*; on Tuesdays and Fridays, except Good Friday (students' days), 6*d.*; a charge of 3*d.* is made for the admission of photographic apparatus. Bath-chairs will be permitted to enter the gardens during public hours when the condition of the paths is suitable on payment of 1*s.* on students' days (Tuesdays and Fridays, except Good Friday), and on payment of 6*d.* on other days. Students' permits, available until the close of the calendar year, and obtainable on written application to the director by *bonâ-fide* students and artists, will be issued on payment of a fee of 5*s.* These permits will cover free entrance on students' days and before public hours on week days, except Good Friday and Bank Holidays. Season tickets, available until the close of the calendar year, can be obtained on written application to the director on payment of a fee of 1*l.* These tickets will cover admission on any day during public hours.

WE learn from *Science* that, at the request of President Wilson, the National Academy of Sciences has appointed the following to investigate and report on the control of the Panama land-slides:—President C. R. Van Hise, University of Wisconsin (chairman); General H. L. Abbott, Cambridge, Mass.; Dr. G. F. Becker, United States Geological Survey; Prof. J. C. Branner, Stanford University; Dr. Whitman Cross, United States Geological Survey; Dr. A. L. Day, Carnegie Institution; Dr. J. L. Hayford, Northwestern University; Prof. H. F. Reid, Johns Hopkins University; Dr. R. S. Woodward, Carnegie Institution; C. Carpenter, Ithaca, N.Y.; A. P. Davis, United States Reclamation Service; J. R. Freeman, Providence, R.I.

WE notice that Dr. J. N. Rose, of the United States National Museum, and his assistant, Mr. Paul G. Russell, have recently returned from an extensive journey in Brazil and Argentina, where they have been engaged especially in making a collection of Cactaceæ from the South American desert regions. The expedition was undertaken in connection with the exhaustive study of the Cactaceæ of North and South America, which Dr. Rose is making for the Carnegie Institution of Washington. In addition to the extensive collection of herbarium material which has been brought to the National Museum, large collections of plants in a living condition were brought back and are now on exhibition in the New York Botanical Garden. The publication of Dr. Rose's results of his journey will be eagerly awaited, and cannot fail to be of as great interest and value as his former contributions to the desert botany of the United States.

A GENEROUS tribute to the memory of the late Prof. Meldola was paid, we learn from a report in the *Times*, by Lord Reading, the Lord Chief Justice, at a meeting of the Maccabean Society on December 14. Lord Reading said:—Humanity and science were both mourners and sufferers by the death of Prof. Meldola. No one whose life was not spent in science could have any conception of the varied aspects in which Prof. Meldola touched life and adorned it, and of the wide outlook which he had over the world. He was in every respect a most lovable man. Since the war, he had done much work for the Government, by whom it was highly valued. There must come eventually a period of reconstruction in the country, and when that time came we should miss the work which Prof. Meldola could have done. He had left a lasting memorial of himself in all his life, not least in the last part of his life.

FOREMOST in the equipment of the protagonist of airships is a plentiful supply of optimism; possibilities must perforce loom much larger than actual achievement when the latter is meagre. In an article entitled "Possibilities of the Large Airship," contributed to the *Fortnightly Review* for December, Mr. A. J. Liversedge does not trouble much over the technical difficulties of large airships, being concerned chiefly to prove that they are "worth while." In fact, he regards the construction of large semi-rigid dirigibles as being well within the capacity of borough engineers or surveyors, assisted by "woodworkers, handymen, and youths and female labour." "Plans, the necessary direction, and the finance would, of course, be provided by a central authority. . . ." Mr. Lloyd George would provide the engines through the Ministry of Munitions. We may believe in large airships and their usefulness both in war and peace, without visualising them coming quite in that fashion. It smacks too much of an article in one of the domestic periodicals describing how, with the aid of "a friendly carpenter," a packing-case becomes a sideboard or a wardrobe. Mr. Liversedge's optimism seems of the wrong sort, and his visions of the functions of airships in war somewhat awry, ignoring as they do in many cases the possibilities of easy destruction, by the enemy, of the airship. But to one who is so optimistic about their production, the loss of one or two would not perhaps matter.

THE collection of gem-stones formed by the late Sir Arthur H. Church has, in accordance with a wish expressed in his will, been presented by his widow to the trustees of the British Museum, and is now on exhibition in the recent addition case in the Mineral Gallery of the Natural History Museum at South Kensington. It comprises about two hundred selected and choice faceted stones, most of them mounted in gold rings, and the whole is of considerable intrinsic value. The stones are referable to twenty-one mineral species, so that, with the notable exception of diamonds, most of the species that have been used in jewelry are represented. The interest of the collection, however, lies more in the strong suites afforded by certain species, illustrating well the wide ranges of colour which may be exhibited by one and the same kind of

stone. This is particularly the case with zircon, a mineral to which Sir Arthur Church had devoted much study, though unfortunately he had not completed his observations or prepared them for publication. Of this species there are sixty-nine faceted stones, ranging from colourless to various shades of red, brown, yellow, green, and even sky-blue. Other strong suites are of tourmaline, garnet (including a fine example of spessartite, the rare manganese-garnet), spinel, opal, corundum, chrysoberyl, and peridot. Examples of rarer species represented in the collection are phenakite, andalusite, and enstatite.

BY means of a submerged chamber, provided with large glazed apertures and entered through a tube attached to the well of a specially constructed barge, the brothers G. and E. Williamson have devised a means whereby they can take kinematograph pictures of marine animals and make surveys of the ocean floor, down to a depth of as much as 30 fathoms. The complete success of their ingenious method was demonstrated at a private view, given on Tuesday afternoon, at the Philharmonic Hall, London, and the exhibition will be open to the public in a few days. Some remarkable pictures, taken in the Bahamas, were thrown on the screen, showing "snappers" and other fish which haunt coral reefs, divers gathering sponges, sharks attracted by a dead horse suspended in front of the observation chamber, and, finally, an encounter with a shark by one of the inventors of the apparatus. Pictures taken at night, by means of several Cooper-Hewitt mercury vapour lamps, were also shown. The inventors claim that their apparatus will enable treasure to be raised from vessels sunk in shallow water with far more ease than hitherto, since they have devised a means of pushing the arms through special apertures, enabling the diver to seize objects seen through the observation chamber. Another and very real advantage of this method of submarine work is that the operator is enabled to remain at work for long periods without suffering the discomforts inseparable from the ordinary means of diving. From a spectacular point of view it is to be hoped that the inventors will be able further to improve on their chamber, for it is distinctly distracting to see the floor of the ocean heaving to slow music while fishes of various bizarre shapes and colours disport themselves for our edification. This movement is at present inseparable from the rise and fall of the barge with the swell. If the chamber could rest on the bottom, by lengthening the tube, this motion would be avoided.

THE director of the Meteorological Office informs us that during the last three months a number of auroras have been reported by Mr. G. A. Clarke, the observer at King's College, Aberdeen. His latest report on the subject refers to a fine display commencing about 6 p.m. on December 6, and lasting until after midnight. It seemed to attain its maximum between 8 p.m. and 10 p.m. About 9.30 p.m., according to Mr. Clarke's report, a very extensive and bright glow, topped by a narrow arch, stretched from N.E. right round to W. Above this arch at an elevation of 60° from the horizon were some streamers, and a series of very fine rapid pulsations of light of a pale green white to lavender or pale rose tint. The arch and glow were pale greenish, and gave sufficient light to form faint shadows of buildings, similar to what occurs in faint moonlight. This aurora was accompanied, as has been the case with most of the auroras reported recently by Mr. Clarke, by a good deal of magnetic disturbance. At Kew the curves were considerably disturbed during the whole afternoon of December 6, and up to 4 or 5 a.m. on December 7. The total range of declination was about 49′, and that of horizontal force about 170γ ($1\gamma = 1 \times 10^{-5}$ C.G.S.). The most outstanding declination movement at Kew took place between 9.55 and 11.40 p.m.; during this time the needle swung 28′ to the east, and returned practically to its original position. The most notable horizontal force change was a rise of 150γ between 10.20 and 10.45 p.m. These changes, it will be noticed, occurred somewhat later than the hour when the aurora at Aberdeen was most brilliant.

A USEFUL popular account of fleas by Mr. F. C. Bishopp has been issued by the United States Department of Agriculture (Bulletin 248). The life-history of these familiar insect parasites is sketched, and their importance as carriers of bubonic plague and other diseases is duly emphasised. Practical measures for exterminating fleas and gaining protection from their attacks in infested localities are not forgotten; for example, a man sitting in a room inhabited by the insects is advised to wrap his legs with flypaper, or to wear khaki trousers and have them "tucked into high-top shoes."

A KNOWLEDGE of the life-histories of the ecto-parasites of man is, at the present moment, of vital importance to us all, and especially to those of our countrymen who are on active military service. We are glad, therefore, to see in the Journal of the Royal Society of Arts the report of a lecture on this theme by Dr. A. E. Shipley, the master of Christ's College, Cambridge. Herein Dr. Shipley, in his own inimitable way, gives a brief account of the habits and habitats of the head and body louse, the flea, and the bed-bug, and the diseases spread by them. By way of illustrating the devious ways in which these pests extend their range, he remarks of Cimex, the bed-bug, that it was unknown to the aboriginal Indians of North America, and probably, therefore, "entered that continent with the 'best families' in the *Mayflower*"! Other disease-bearing insects, like mosquitoes, tsetse- and other biting-flies, house-flies, and bluebottles and other insects which spoil the food of man, like flour-moths and biscuit "weevils," are each in turn passed in review, and their ravages explained.

IN the *Scottish Naturalist* for December Mr. A. Landsborough Thomson continues his notes on the Aberdeen University bird-marking scheme. We would suggest that where birds are recovered which were ringed as nestlings at the same time and place it would be helpful if it was stated whether they were nest-fellows. A case in point occurs in Mr. Thomson's notes. Two sheldrakes were ringed as nestlings at Beaulieu, Hampshire, in July, 1912; one was recovered

at Saltash, Cornwall, in February, 1913, the other at Busum, in Schleswig-Holstein in August, 1913.

THAT closely similar and nearly related species may sometimes be more easily distinguishable by their behaviour than by their physical characteristics is shown by Mr. Walter Ritchie in the *Scottish Naturalist* for December, wherein he describes "The Smaller Pine Beetle (*Myelophilus minor*) in Aberdeenshire." *M. minor* and *M. piniperda* are two small bark-beetles, which are to be distinguished one from another only after very careful scrutiny. Yet the tunnels which they drive beneath the bark of trees are strikingly different in character, so that there can be no possible confusion in the plan of the mother and brood-galleries of the two species. The mother-gallery of *M. piniperda* forms a vertical shaft from which the very long larval galleries are given off on either side at right angles. In *M. minor* the mother-gallery is biradiate, and runs transversely to the long axis of the tree-trunk, while the larval-galleries are very short, and running at right angles to the mother-gallery. They thus come in consequence to run in the same direction as the mother-gallery of *M. piniperda*.

PARTS 10 (Series A and B) of the third volume of the *Review of Applied Entomology* have just been issued by our Imperial Bureau. Of special interest among the summaries of foreign literature are accounts of Prof. N. A. Cholodkovsky's latest work on the Chermesidæ (Dept. Agri., Petrograd, 1915), and if Dr. O. N. Paleitchuk's detailed instructions for the treatment of bees infected with *Nosema apis*. Unfortunately we are not told if the prescription, when adopted, proved effectual.

THE Consular Report (Annual Series, No. 5496, 1915) on San Thomé and Principe indicates the remarkable success achieved by the Portuguese authorities in their drastic measures taken to exterminate the tsetse-fly and sleeping sickness on these islands. The death-rate has fallen steadily, and in 1914 only 52 people died of the disease at Principe; only eight persons on the island were still suffering from it, and they were all old cases. The conquest of the epidemic has no doubt been due to the campaign against the tsetse-fly. None have been caught since April 11, 1914, although the reward has been raised from one to five dollars per fly. Thirty-four flies were caught in 1914. The report remarks:—"Apparently there is every reason to believe the fly has now been completely exterminated in the island."

THE Records of the Indian Museum, vol. xi., part 4, contains some valuable notes on Indian parasites of fish by Mr. T. Southwell. He is of opinion that some species at least of the larval Trematodes which live in the skin and flesh of fishes may mature in the human intestine. The ectoparasitic crustacean, *Argulus foliaceus*, he found to be a serious menace in confined tanks. This was demonstrated in the case of a number of Indian carp (*Labeo rohita*), which, about a month after being placed in the tank, became sluggish and floated on the top of the water. When removed they were found covered with Argulus. All the fish were then captured, scraped clean, and returned to the water. An upright bamboo was then placed in the centre of the tank, and this was immediately used by the fish as a mean of rubbing off their unwelcome adherents. No more deaths occurred after this date. It is unlikely that frogs assisted in keeping down this parasite, though the author inclines to this view.

ACCORDING to the theory of parallel axes, any quadratic function of the co-ordinates and their rates of change of a system of masses may be represented as the sum of two terms, one being the same as if the whole mass were concentrated at the centre of mass, and the other representing the corresponding function of the relative co-ordinates and their rates of change referred to the centre of mass as moving origin. Unfortunately, however, there has been a tendency in certain quarters to reproduce misstatements in which similar properties are alleged to hold good with regard to points other than the centre of gravity. Prof. E. Bidwell Wilson communicates to the American *Mathematical Monthly*, vol. xxii., No. 6, a note on "Linear Momentum, Angular Momentum, and Kinetic Energy," in which it is sought to enunciate the precise forms which these dynamical magnitudes assume when expressed in terms of the motion of an arbitrary point and of the relative motion of the system with respect to that point. It is desirable that these results should be studied in detail by teachers of mechanics, but it will be evident from a perusal of the paper that the student should be warned invariably to choose the centre of mass as the moving point with respect to which the dynamical magnitudes under consideration are expressed as the sum of two terms. We have seen it stated that in forming equations of motion it is only possible to take moments about either a fixed point, the centre of gravity, or the instantaneous centre in the case of small oscillations. As a matter of fact, moments may be taken about any point whatever provided that the mass accelerations of the system are properly specified in the form of a force through the centre of gravity and a couple.

THE Journal of the Washington Academy of Sciences for November 19 contains an abstract of a paper on the mechanical properties of zinc-bronze by Mr. H. S. Rawdon, of the Bureau of Standards, which will ultimately appear in full in the Bulletin of the Bureau. The alloy has the composition, copper 88, tin 10, and zinc 2 per cent., and considerable variation in the method of preparation may be made without the structure being seriously affected. In the cast condition it consists of a matrix of relatively large crystals of a solid solution of tin and possibly zinc in copper, in which are embedded numerous particles of a hard, brittle eutectoid. When broken in tension the fracture occurs along the cleavage planes of these crystals, and their size and relative positions in the cross section of a test bar have a considerable effect on its strength. The most serious cause of fracture is, however, the

presence of oxides in the form of pits and films, and in almost all cases in which a test bar failed under a load less than 35,000 lb. per sq. in., the failure was traced to these oxides of tin and zinc.

AT the end of last year the important plumbago mining industry in Ceylon was suffering very severely from the loss of the German and Belgian markets and from other causes connected with the war, and steps were taken by the Imperial Institute to induce users of plumbago in the United Kingdom to buy the whole of their supplies from Ceylon instead of partly from Ceylon and partly from foreign countries as previously. Recent statistics indicate that progress has already been made in this direction, for it is significant that the percentage of Ceylon plumbago exported to the United Kingdom during the first ten months of the present year is considerably greater than in 1913. Moreover, the total exports to this country from January to October this year are more than double those of the corresponding months in 1914, and, in addition, Russia is a large new purchaser. The most important use of plumbago is in the manufacture of steel works crucibles, which are required to resist the effects of great variations of temperature; and it is gratifying to know that a source within the British Empire is available to supply the demands of our munitions works for these articles.

THE Cambridge University Press will publish very shortly a supplementary volume of Scientific Papers by Sir George Darwin. It will be edited by F. J. M. Stratton and J. Jackson, and contain lectures on Hill's lunar theory, a paper on periodic orbits, the inaugural lecture delivered in 1883 on the author's election to the Plumian professorship at Cambridge, and an address to the International Congress of Mathematicians in 1912. In addition, the volume will include memoirs of Sir George Darwin by, respectively, Sir Francis Darwin, on his life apart from his scientific work, and Prof. E. W. Brown on Darwin as astronomer, mathematician, and teacher.

OUR ASTRONOMICAL COLUMN.

o CETI.—The maximum of this star is not "due" until January 8, 1916, but strict regularity is not a feature of its light curve, and it has already reached 3·0 magnitude (December 16), being only slightly less than α Ceti (2·7 mag.), and is thus a full magnitude brighter than at the last maximum. The present apparition strongly recalls that of December, 1906.

COMET 1915*e* (TAYLOR).—Since this comet was observed at Washington many observers have managed to find it. An observation made with the 10-in. refractor at the Hill Observatory on Thursday, December 16, 13h., gave the following approximate position, R.A. 5h. 16·7m., declination +2° 13′, whence it appears that the daily movement is accelerating. As the comet is evidently approaching, increasing in brightness and very favourably placed for observation, it may be expected to become a fairly conspicuous object.

From observations made on December 6 at Washington, and on December 9 and 12 at Copenhagen, Messrs. Braae and Fischer-Petersen have calculated the following orbit and ephemeris:—

$T = 1916$ Feb. 26·426 t.m.B.
$\omega = 18° 27′ 38″$
$\Omega = 107° 6′ 55″$ } 1915·0
$i = 21° 52′ 59″$
$\log q = 0·19358$

		R. A. h. m. s.		
Dec. 25	...	5 11 1	...	δ+5° 7′·6
29	...	8 34	...	6 40·3
Jan. 2	...	6 22	...	8 21·8

The comet's distance from the sun diminishes from 172 to 160 million miles between December 13 and January 2, and it comes about ten million miles nearer the earth in the same time. On December 12 it is stated to have been of about the eleventh magnitude.

GEMINID METEOR SHOWER.—Mr. Denning sends the following notes of observations of this shower:—Mrs. Fiammetta Wilson, observing from Wokingham, on December 11, 6h. 30m., to midnight, saw thirty-seven meteors, of which nearly one-half were Geminids, from a radiant at 109°+32°. On December 11 thirty-two meteors were seen before midnight, and a very distinct radiant was found at 117°+31°.

Miss A. G. Cook observed the shower from Stowmarket on December 11 until interrupted by clouds at 10.30. The radiant was at 109°+33°.

Mr. T. Hargreaves, at Eton, watched for meteors on the evenings of December 11, 12, and 13, and morning of 14, and recorded forty, of which about eight, seen from 12h. 28m. to 13h. 16m. on December 13, were Geminids with a radiant at 111°+30°.

Mr. Denning, at Bristol, looked out on December 12, 15h. 30m. to 18h., and in about 1¾ hours of that interval saw twenty-five meteors, 18 per cent. of which were from a double radiant at 110°+33° and 118°+32°. Clouds prevented observation on December 13 and 14, but on December 15, 15h. 40m. to 16h. 10m., thirteen meteors were counted. Not a single Geminid was seen; the shower appeared to be over.

On December 15, 8h. 23m., a fireball was seen from Bristol falling low in due north, path about 207°+53° to 210°+47°. It must have been a splendid object from the north of England and south of Scotland.

Judging from the results of the foregoing and some other observations, it seems certain that the display was not above the normal character. Moonlight, however, partially interfered, and several cloudy nights at the most important period prevented efforts to corroborate the easterly motion of the radiant.

NOTES ON VARIABLE STARS.—A sudden maximum of UV Persei was observed by E. Hartwig (*Astronomische Nachrichten*, 4815) on September 2, the star reaching 11 mag., although less than 13–14 mag. on August 28. On September 4 it was again invisible. This fleeting illumination was also observed by Prof. A. A. Nijland (*Astronomische Nachrichten*, 4818), who reports that the star could not be found on August 31. On September 3 it was as bright as the comparison star, but the following night had vanished. The previous maximum occurred on June 19, 1914—*i.e.* 434 days earlier.

Some interest attaches to a new variable star, 4, 1915 Orionis (1900, 4h. 58m. 46s., −4° 20·8′), discovered by Mr. J. Voûte, who, seizing a fortuitous opportunity, observed it passing through an extraordinary fluctuation of light last September (*Astronomische Nachrichten*, 4821). Estimated magnitudes were:—

1915	Sept. 12	8·5 mag.	Sept. 28	7·12 mag.
	Sept. 23	6·4 mag.	Oct. 4	8·3 mag.

The variability of RU Cassiopeiæ and the neighbouring star, P.D. 695, was not supported by photographic measures recently published by Dr.

Münch. The visual observations made by von Guthnick during the summer of 1911 (*Astronomische Nachrichten*, 4818) show that the average amplitude of the light curve is 0·25 mag. in each case, and the periods are just about one day. With magnitudes about 5·8 and spectra of the usual advanced helium type (B8–B9) either would supply the Ottawa observers with just the stiff kind of spectroscopic problem they seem to revel in.

The light curve of a new Algol star, 3, 1915 Coronæ (BD+30°, 2688, 9·1 mag.) has been published by von Cuno Hoffmeister (*Astronomische Nachrichten*, 4821) who first detected its variability during August, 1914. A series of observations, including fifteen minima, gives the following elements:—Period, 17h. 26m. 4·18s.; normal magnitude, 9·28; minima, 9·76; duration of phase, 4·3 hours.

A TUNGSTEN ARC LAMP.

A NEW and extremely interesting development of the nitrogen- or argon-filled electric lamp is described in a paper by Messrs. E. A. Gimingham and S. R. Mullard in the Journal of the Institution of Electrical Engineers for December 1. The lamp is the result of experiments started in 1913 in the Edison and Swan United Electric Light Co.'s laboratory. Instead of the light being emitted by an incandescent spiralised filament of tungsten, it is given out by an actual arc between tungsten electrodes.

The first problem to be solved was, of course, to strike the arc. In the first forms of lamp, two tungsten electrodes were normally in contact, and an expansion strip consisting of a strip of molybdenum, to one side of which was welded a thin strip of copper, was fixed to one of the electrodes. This strip was heated by a spiral filament of tungsten, in series with the electrodes. It was found, however, that the electrodes were frequently partially fused together, so that the expansion strip failed to separate them, in addition to which a certain amount of spluttering occurred, which shortened the life of the lamp. To overcome this defect, an entirely different method was employed, enabling the arc to be struck between fixed electrodes consisting of two small globules of tungsten. A tungsten filament was made to glow close to the electrodes, and ionised the gas between them. This made the gas conducting. The ionising filament was connected in parallel with the arc circuit, and was connected up for a few seconds only by means of a switch, and then disconnected as soon as the arc was properly struck.

In continuous-current lamps, however, difficulty was experienced in inducing the arc to leave the filament and pass to the negative electrode. The heat of the arc, moreover, destroyed the ionising properties of the filament. To cure this, two expedients were adopted. First of all, instead of a simple tungsten filament, it was found that better ionising properties could be obtained from a mixture of tungsten with zirconia, yttria, thoria, and other refractory oxides, and that, in addition, such a filament had a longer life. Secondly, the use of the expansion strip was reverted to for the purpose of moving the positive electrode along, after the arc had been struck, to another part of the filament, which acts as the negative electrode, and saves the central part of the latter (opposite to which the positive electrode returns when the lamp is switched off) from being rendered inactive.

Such a lamp is shown diagrammatically in Fig. 1. The current first passes through the circuit A and the filament BB′, while at the same time there is the full potential difference of the mains between the tungsten globule, E, and the filament. The gas in this gap is ionised, and the arc strikes. As the main current then passes through the relay C, this is actuated, and breaks the ioniser circuit. Meantime the heat from the arc causes the expansion strip F to warp, and moves E further along the filament.

Alternate methods, used for lamps of higher candle-power, are to arrange the ionising filament and the electrode, so that, after striking, the arc rises away from the active part of the filament, or to employ two electrodes and a change-over switch. In the latter case, the arc is first struck between the filament (connected to the negative pole) and the smaller electrode as anode, and as soon as the latter becomes brightly incandescent, the filament is switched off and the polarity changed, so that the arc is formed between a larger positive electrode and the smaller one, which is now negative.

The efficiency of the lamp, for a life of a few hundred hours, is in the order of ½ watt per c.p., and the intrinsic brilliancy of the light source about 10,000 c.p. per sq. in. Spectrum analysis shows perfect continuity and strength over the whole visible spectrum, and at the same time richness in the ultra-violet.

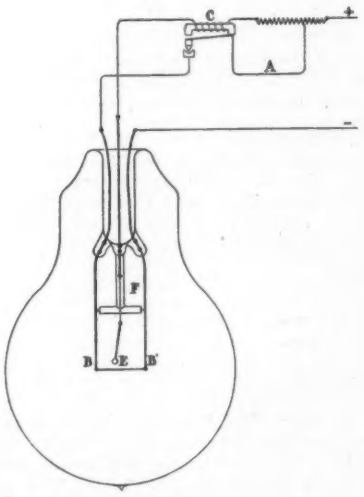


FIG. 1.

One of the immediate applications of the new lamp is for projection purposes, and the manufacturers have already placed on the market a practical form of lantern lamp, with a resistance arranged so that it may be set for any voltage. This lamp is simply started by means of a push switch, which closes the ioniser circuit, and is to be released as soon as the arc is struck. In its smaller sizes the lamp will doubtless displace entirely the Nernst filament which, in spite of its disadvantages owing to the negative temperature coefficient rendering it very sensitive to pressure variations, has been used very largely for small projectors, surgical examination lamps, etc., and has remained popular until the stock of the German Nernst burners in this country at the outbreak of the war became exhausted. For photographic enlargement lamps it should also have a useful field, and, ultimately, as a substitute for arc lamps for kinema theatres, and the internal lighting of shops and large buildings. The spectrum shows that it should be invaluable for colour matching.

THE WORKING AND MAINTENANCE OF STEAM BOILERS.

IN these days of high-priced coal, the memorandum which has recently been issued by Mr. C. E. Stromeyer, chief engineer of the Manchester Steam Users' Association, will be read with much interest by engineers and boiler owners. The coal bill for a Lancashire boiler amounts to from 300*l.* to 600*l.* per annum, and careless stoking may easily increase this cost in a very large proportion. Lack of proper attention to minor defects, which should be remedied as soon as detected, may also greatly increase the coal bill and shorten the life of the boiler. The memorandum covers a very wide field, such as economiser defects, external and internal corrosion, leakage, etc. Of special interest are Mr. Stromeyer's remarks regarding mechanical stokers.

Experience indicates that mechanical stokers, which naturally aim at improved efficiency and therefore high furnace temperatures, require not only that they should be carefully looked after and kept in good repair, but also that the boiler should receive far more care and attention than are necessary with hand-firing. Scale, and to a certain extent grease, may be tolerated in hand-fired boilers, but every effort should be made to remove these injurious substances if increased economy is aimed at by the adoption of mechanical stokers. Mr. Stromeyer gives some illustrations of the increased liability to damage due to increase in the temperature of the furnace. The boilers of a large steamer had been giving no trouble until an improved fire-grate was fitted. A saving of about 10 per cent. in the coal bill resulted, but during the next voyage all the eighteen furnaces gradually bulged, in spite of a reduction of speed and power. The bulging could have been stopped if the improvement due to the new grate had been nullified either by keeping the furnace doors open and admitting an excess of cold air, or by closing all airholes in the doors, restricting the air admission but spoiling the efficiency.

Mechanical stokers designed to burn anthracite will almost certainly fail if fed with coking coal, and *vice versa*. It is not possible to design a mechanical stoker which shall be satisfactory with all classes of coal.

From an economical point of view it is more important to keep the boiler heating surfaces free from soot and tarry matter than to remove the scale from the interior surfaces; the wear and tear question, however, demands that the inside of a boiler should be kept clean. Scale and grease hinder the heat which enters the plate from passing into the water. The radiating power of incandescent fuels, or flames, increases as the fourth power of the temperature, hence boilers which have worked satisfactorily, but inefficiently, with a comparatively low furnace temperature, even though the plates may be covered with scale or grease, are likely to give trouble if the furnace temperature, and with it the efficiency, are increased. It is not strictly true to say that scale and grease reduce the efficiency of a boiler; they merely make it unprofitable to adopt an efficient system of combustion.

Slow bulging of the furnaces may be caused by the deposition of scales of crystals from any boiler water containing more than 4 per cent. of soluble salts. It is more than probable that plates which on one side are exposed to an intense heat, are on the other side covered chiefly with bubbles and sprays of burst bubbles, which leave their dissolved salt on the boiler plate while the water is evaporated. If the intense heat and rapid evaporation can be maintained locally, and this seems to be the case if mechanical stokers are worked very hard, crusts of salt will form here and there on the heating surface. Sometimes they will be washed away with a slight change of evaporation or circulation, but sometimes they will remain attached to the plates for a sufficiently long period to cause overheating. Drops of water which fall on hot plates are in a spheroidal condition, do not wet the plate, and consequently will not dissolve any salt scale which has formed there. As soon as a little bulging has been effected, the salt crusts will doubtless break off, but as bulges are exposed to the flames more than other parts, salt crusts are likely to reform in them, and gradually the bulge grows larger and larger until it is detected. As soon as the fire is drawn the salt crusts are dissolved away, and the bulges are said to be due to mysterious causes. This danger is naturally greatest with boilers having a bad circulation.

BEHAVIOUR OF PLANTS IN RESPONSE TO THE LIGHT.[1]

IN the whole realm of biological science there is perhaps no phenomenon of greater fundamental importance than that exhibited by green plants in the transformation of carbon dioxide and water into starch and sugar. That this can only take place through the action of light upon chlorophyll is commonplace knowledge, but exactly how it is effected we do not know. Of the light that falls upon a green leaf a part is reflected from its surface, a part is transmitted, and another part is absorbed. That which is reflected and transmitted gives to the leaf its green colour; that which is absorbed, consisting of certain red, blue, and violet rays, is the source of the energy by means of which the leaf is enabled to carry on its work.

The extraordinary molecular complexity of chlorophyll has recently been made clear to us by the researches of Willstätter and his pupils; Usher and Priestley and others have shown us something of what takes place in chlorophyll when light acts upon it; and we are now beginning to realise more fully what a very complex photo-sensitive system the chlorophyll must be, and how much has yet to be accomplished before we can picture to our minds with any degree of certainty the changes that take place when light is absorbed by it. But the evidence afforded by the action of light upon other organic compounds, especially those which, like chlorophyll, are fluorescent, and the conclusion according to modern physics teaching that we may regard it as practically certain that the first stage in any photo-chemical reaction consists in the separation, either partial or complete, of negative electrons under the influence of light, leads us to conjecture that, when absorbed by chlorophyll, the energy of the light-waves becomes transformed into the energy of electrified particles, and that this initiates a whole train of chemical reactions resulting in the building up of the complex organic molecules which are the ultimate products of the plant's activity.

The absorption of light by the leaf is therefore of great physiological importance, and we have only to look at any of the plants around us to see how successfully they contrive to arrange their leaves to obtain the maximum advantage from the light that falls upon them. A plant organ responds to the directive influence of light by a curvature which places it either in a direct line with the rays of light as in grass seedlings, or at right angles to the light as in ordinary foliage leaves.

[1] Evening discourse delivered before the British Association at Manchester on September 9, by Dr. Harold Wager, F.R.S.

Formerly it was thought that the light acts directly on the part that bends, but the researches of C. and F. Darwin more than thirty years ago proved that in young seedlings this is certainly not the case. They showed quite conclusively by means of a large number of carefully contrived experiments that the heliotropic curvature in the lower part of a seedling is determined by the illumination of the upper part. Consequently no curvature can take place until a stimulus has been transmitted from the upper part, which behaves as a light-perceiving organ, to the lower part in which the motor response takes place.

Foliage leaves are not usually so sensitive to light as the plumules of young seedlings, and do not in many respects so readily admit of experimental investigations. We know that the leaf-stalk bends towards and tends to place itself parallel to the rays of light, and that the leaf-blade places itself at right angles to the rays of light. We know that when the leaf reaches the position of maximum advantage the movement towards the light ceases, and it then remains fixed, except for slight circumnutating movements, until either the direction of the light changes or its intensty is decreased. But we do not yet know —and the problem is not an easy one to solve—by what means the leaf is enabled to adjust its position to the direction of the rays of light, nor just how it perceives that it is or is not in the most advantageous position.

FIG. 1.—*Eranthis hiemalis.* Leaf stalks curving towards light coming in the direction indicated by the arrow.

Dutrochet suggested, without any experimental evidence to support it, that the lamina of the leaf exerts an influence on the movement of the leaf-stalk. Hanstein also considered that the lamina was the light-sensitive part of the plant, and even went so far as to compare it with the retina of the eye. C. and F. Darwin were the first to attempt to determine the point experimentally.

Pieces of blackened paper were gummed to the edges and over the blades of some leaves on young plants of *Tropaeolum majus* and *Ranunculus ficaria*; these were then placed in a box before a window, and the petioles of the protected leaves became curved towards the light as much as those of the unprotected leaves.

Rothert repeated Darwin's experiment on Tropæolum, and found that the leaves reach the right position whether darkened or not. Krabbe also showed by his experiments on Phaseolus and Fuchsia that when the leaf-blades were darkened the leaves reach the right position just as readily and as precisely as the undarkened leaves. On the other hand, Vöchting came to the conclusion from his experiments on Malva that the curvature of the leaf-stalk only followed when the blade of the leaf was illuminated.

Haberlandt concluded from his experiments on a variety of leaves that in some cases the lamina is the only percipient organ, that in others both lamina and leaf-stalk are concerned, and that in very few cases is the leaf-stalk or pulvinus alone responsible. He considers that when both lamina and leaf-stalk are concerned the larger movement is probably brought about by the leaf-stalk and the finer regulating movement by the lamina.

The experiments which I am about to describe are concerned in the first instance with the problem: Does the lamina perceive the light, or is the leaf-stalk the percipient organ, or do both take part in it?

The observations were carried out by a method suggested by the extremely ingenious and charming device employed by F. Darwin to prove that the geotropic sensitiveness of the plumule of a grass seedling is localised at the apex. It consists essentially in keeping the blade of the leaf fixed while the petiole is free to move. Thus if the blade of the leaf is kept in a horizontal position and then exposed to oblique light, what effect will be produced on the petiole? If it is free to move, the petiole ought to curve towards the light; and if the stimulus is localised in the leaf-blade, the curvature ought theoretically to continue so long as the stimulus continues to act and the petiole is capable of growth.

The experiment was first of all tried with a number of leaves of *Eranthis hiemalis*. The leaves were carefully removed from the plant; the blades were then attached to a glass plate, and the stalks were allowed to hang downwards in a glass vessel containing water.

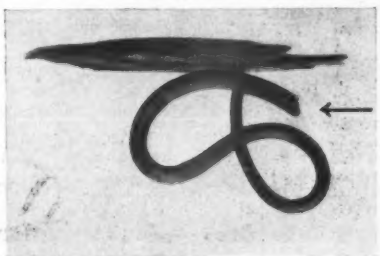


FIG. 2.—*Tropaeolum majus.* Leaf exposed to lateral light and then turned round. The curvature of the petiole becomes reversed.

On exposure to an oblique lateral light the stalks very soon began to curve towards the light, and continued to curve in the same direction for several hours, until in many cases a complete spiral was formed (Fig. 1). Similar results were obtained with the leaves of many other plants. If a leaf in the petiole of which this heliotropic curvature has been induced is turned round so that the light impinges upon it on the opposite side, the curvature becomes reversed (Fig. 2).

The advantages of this method are that the leaves are not submitted to the rough treatment necessary to darken the blades or stalks, and, secondly, there is less interference with the respiratory and assimilatory functions. The disadvantages are that the leaf-stalks, being free to move, may be stimulated by gravity, and the pronounced curvatures thus induced may, unless proper precautions are taken, be mistaken for phototropic curvatures. So long as it is approximately vertical, the leaf-stalk is not influenced, or only slightly, by gravity, but immediately it moves from the vertical in response to the light stimulus, the influence of gravity comes into play, and light in conjunction with the gravitational stimulus takes a share in effecting its curvature. As soon, however, as the leaf-stalk in its upward movement passes beyond the vertical, the gravitational stimulus tends to bring it back to the vertical position, and the light stimulus then, in order to effect any further curvature, has to continue its action against the force of gravity.

A striking experiment to show that curvatures may be effected by the phototropic stimulus against the gravitational stimulus was made by placing leaves upside down. Three young leaves of *Eranthis hiemalis* had their leaf-blades securely fixed between two pieces of black cardboard, the leaf-stalks passing through small holes in one of the pieces of card. The leaves were then placed with the stalks projecting upwards in water in a rectangular glass vessel. Three sides of the glass were darkened, the other side was exposed to a dull lateral light. In the course of the day (Fig. 3) the stalks curved distinctly towards the light against the force of gravity which tends to keep them vertical.

In all these experiments the light was allowed to act upon the whole of the leaf, both blade and leaf-stalk, but as in many cases the leaf-stalk itself is phototropically sensitive, it was important to determine to what extent either of these organs, submitted separately to the influence of light, might bring about the curvature. Accordingly, experiments were made by which the leaf-blades only were exposed to oblique light. This was done by fitting a light tight cover over an opaque vessel containing water. The stalks of the leaves were passed through small apertures in the cover and allowed to hang down in the water. The blades resting on the surface of the cover

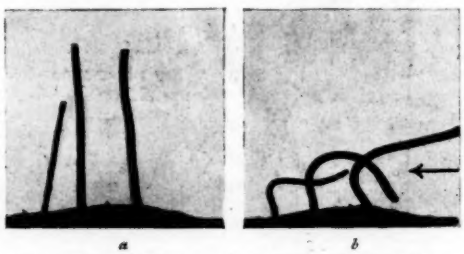


FIG. 3.—*Eranthis hiemalis*. Three leaves placed upside down, with their stalks vertical (*a*); on exposure to light they curved towards it (*b*).

were then covered with a piece of clear glass and exposed to the light. After some time the stalks were found to be curved more or less in different directions, no doubt due to the geotropic stimulus, but there was no definite curvature towards the light, although in many experiments the leaves were exposed to the light for a week and even longer.

When, however, the leaf-stalks are exposed to the light and the blades kept in the dark, the stalks all curve distinctly to the light. A large number of leaves belonging to different families of plants was tested in this way, and the result was always the same. The conclusion therefore seems justified that the perception of light is located not in the leaf-blade but in the leaf-stalk.

The further problem then arises: Does the whole of the leaf-stalk perceive the light or only a portion of it? Have we in the leaf-stalk, as found by C. and F. Darwin in the plumules of seedlings, a percipient region and a motor region separated from one another? To answer this question a simple piece of apparatus was devised, consisting of a shallow box about 10 mm. high, with a thin base and a thin top, leaving a space of about 7 or 8 mm. between them. This was open at one end, and fitted light-tight over an opaque vessel containing water. Through small holes in the top and bottom of the box the leaf-stalks were passed, so that the lower portions were in the dark, the upper 7 or 8 mm. at the apex of the leaf-stalk being exposed to the light. The leaf-blades resting on the upper surface of the box were covered with a piece of black card, and the apparatus was then placed in such a position that light rays entered the box and impinged upon the upper part of the leaf-stalks only. Before the experiment was started, however, in all cases the stalks were allowed to stand for some time in the dark until geotropic curvatures were set up; the position of the leaves was then so adjusted that the darkened parts of the leaf-stalks were all curved in the opposite direction to that of the light incident upon the upper parts.

Under these conditions the heliotropic stimulus was acting in opposition to the geotropic stimulus. The results obtained were most striking. The curvature towards the light was very marked, and distinct spiral curvatures were produced (Fig. 4).

From experiments made in this way on a large number of plants it was found that the apex of the leaf-stalk for a distance of a few millimetres behaves as a percipient region, and is capable of inducing a motor response in the lower part. Experiments were made to determine how much of the apical region it is necessary to expose to the light in order to obtain a response. Leaves of *Geranium pratense* and *Tropaeolum minus* were arranged to allow different

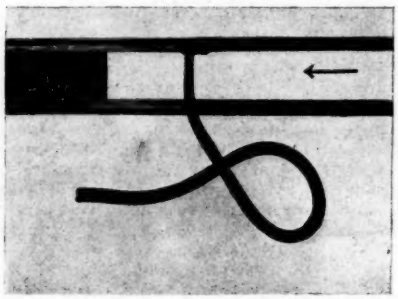


FIG. 4.—*Tropaeolum majus*. Upper 6 mm. of stalk only exposed to light. The direction of the light is indicated by the arrow.

lengths of the apex, 1 mm., 2 mm., 4 mm., 6 mm., 8 mm., and 10 mm. respectively, to be exposed to the light. A distinct response was obtained in each case, but the most definite results were obtained with lengths of from 4 to 10 millimetres.

We have now to consider briefly the mechanics of the movement. The curvature of the stalk is brought about by a more rapid elongation or growth on one side. The tissues of which the stalk is composed are all in a state of strain. The pith and vascular cylinder tend to expand, the cortical tissues to contract. Consequently if the stalk is split down the middle the two halves curve outwards, and, if placed in water, may coil up into a spiral. Now, how does the phototropic stimulus affect this state of strain? What will be the effect of splitting a leaf-stalk that has become curved under the influence of light? Will the two halves coil themselves up in opposite directions as before, or will it be found that the tensions have become modified, and the curvatures also modified in consequence? The experiment was tried on a number of different leaves, and it was found that in all cases the posterior half of the leaf-stalk retains the heliotropic curve, but the end of it tends to coil backwards as before. It is obvious that the light stimulus brings about a permanent change by which the relationships of the tissues to one another as regards their tensions are modified.

Now what will happen if a stalk is split before the heliotropic stimulus is applied? Will the stimulus affect the two halves, or will the posterior half remain

unchanged? To investigate this a leaf-stalk of *Geranium pratense* was split to within 8 mm. of the apex. The unsplit part was then exposed to light, the blade and the lower portion of the stalk being kept in the dark. The result shows (Fig. 5) that the stimulus received by the upper part of the stalk is transmitted to both halves, and the posterior half curves in the direction of the light. The end of the posterior half is, however, coiled backwards as before.

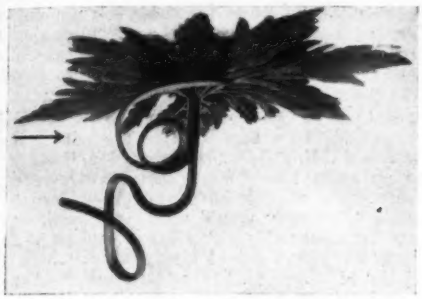


FIG. 5.—*Geranium pratense*. Petiole split to within 8 mm. of the apex and then exposed to light; the lamina was kept in the dark.

If we split a stalk into four we get the same result (Fig. 6); all the four separate parts of the leaf-stalk curve quite distinctly to the light.

Now arises the further interesting problem. If the leaf-stalk is split right up to the apex, will any effect of light be produced in the posterior half? A leaf-stalk split up to the apex was immersed in water for some time until a distinct spiral curvature was produced in both halves. The upper 8 mm. of the two halves were then exposed to light, one half being in front of the other, the blade and remainder of the stalk being kept in the dark. At the end of several hours' exposure to light, not only was the anterior half much coiled—due to the heliotropic stimulus and turgescence of the pith acting together—but the posterior half also showed a distinct curvature to the light in the motor region (Fig. 7). We find, therefore, notwithstanding the fact that two halves of

FIG. 6.—*Geranium pratense*.—Petiole split into four. All four parts curved to the light; the lamina was in the dark.

the percipient region, the anterior and posterior, are completely separated from one another, that the posterior half receives a stimulus as well as the anterior half, and that this determines in it a definite heliotropic curvature. Some attempt was then made to determine (1) what tissues of the stalk are concerned in the perception of light, and (2) the tissues through which the stimulus is conducted. In the first place, the epidermis of the stalk was completely removed and the upper 10 mm. of the stalk then exposed to the light, leaving the blade and the rest of the stalk in darkness. After several hours a definite curvature to the light was obtained, although not so pronounced as in an uninjured stalk. This was probably due to the rough treatment to which the stalk had been submitted by scraping off the epidermis. The experiment, however, shows that the epidermis is not essential either for the perception or the transmission of this stimulus.

Another leaf was then taken and the epidermis together with a part of the underlying cortex removed. In this case also, when the upper part of the stalk was exposed to the light, a definite curvature was obtained. Another leaf had the epidermis and the whole of the cortex removed, but in this case, even after an exposure of three days, no definite curvature to the light was obtained. These experiments indicate therefore that the cortical tissues are those mainly concerned in the perception and transmission of the stimulus. Further, several leaves were taken and transverse incisions were made on opposite sides of the stalk so that the tissues were completely cut across. Here also a distinct but not very pronounced curvature to the light resulted. It thus appears that

FIG. 7.—*Geranium pratense*. The petiole was split up to the apex. The posterior half as well as the anterior half curved distinctly towards the light.

although the perception of light is located in the cortex the stimulus can be to some extent transmitted transversally through the tissues, probably through the parenchyma and pith. That the pith is not necessary, however, was proved by splitting the leaf-stalk longitudinally into two halves and then removing by means of a sharp scalpel the whole of the pith, together with some small portion of the vascular bundles. On exposing the upper part of the stalk thus treated to the light, a definite curvature was obtained in both halves of the stalk.

It appears, therefore, from these experiments that the perception of light is located, probably, mainly in the cortex, but that the transmission of the stimulus may be conducted both longitudinally and transversally through any of the parenchymatous cells of the stalk, and that the motor response, although much more definite and pronounced when the whole of the cortex is present, can also take place when this is partly removed.

We may now ask, What is it that the leaf perceives, the direction of the light rays or the difference of intensity and the illumination on the two sides of the leaf? We cannot answer this question decisively; it is probable that both hypotheses are to some extent

correct. When the stronger light falls upon one side of the leaf-stalk, those cells on the side which is more illuminated are stimulated to activity to a greater extent than those on the less illuminated side, and the stimulus is transmitted to the motor region. Inasmuch as this stimulus is due to physico-chemical changes set up in the cells nearest to the light, the plant may be said to perceive a difference in the effects produced by the light on the two sides—that is, it is able to compare the two intensities. As soon, however, as the leaf reaches its right position, the apex of the stalk is illuminated more or less equally on all sides, and as the physico-chemical changes in the cells may now be considered to be more or less equal, no further stimulus will be transmitted, or, if so, will be transmitted equally all round the stalk, and no curvature in either direction will take place. The leaf now being placed in a definite position with reference to the direction of the light rays, it would seem quite justifiable to conclude that the plant is capable of perceiving the direction of the rays of light.

But the leaf is also capable of distinguishing between light of different wave-lengths. Notwithstanding the fact that rays of light both at the red end and at the blue end of the spectrum are absorbed, the plant responds phototropically mainly to the rays at the blue end of the spectrum, very slightly, possibly, in some cases to the red rays. This has been demonstrated by keeping plants behind different coloured light filters, and also in different parts of the spectrum. That this power is localised in the percipient region at the apex of the leaf-stalk can be very easily proved by exposing this percipient region to rays of the blue or red colour. The filters prepared and spectroscopically examined by Messrs. Wratten and Wainwright can be used for this purpose. Experiments were made with blue, green, and red filters. A strong curvature took place under the influence of the blue rays, but no curvature under the influence of the green or red rays, even when the exposure was continued for more than a week.

Here we have to do, therefore, with the quality as well as with the intensity and direction of the light rays, and the fact that the plant is more sensitive heliotropically to the shorter and more frequent vibrations at the blue end of the spectrum than to the longer and less frequent vibrations at the red end, indicates that it cannot merely be the direction of the light rays that is perceived. Moreover, we must remember that the plant does not respond directly to the action of light, but to the physico-chemical changes that take place in the photo-sensitive cells of the percipient region. We ourselves perceive the light because the brain is able to translate into sense impressions the physico-chemical changes which take place in the elements of the retina. The plant perceives the light because it is able to translate into a motor response the physico-chemical changes taking place in the photo-sensitive cells of the perceptive region.

We may imagine that in the plant the action is as follows: The light is absorbed by, and excites, certain photo-active substances in the cells of the sensitive region. A stimulus is thus set up which is conveyed through the cytoplasmic fibrils of the protoplasts to the motor region. A further impulse is then set up which acts upon the cells in the motor region, by which it is probable that changes in the permeability of the protoplasts are effected; the turgor conditions of the cells are thereby differentially altered, and the result is a motor response. We have here, in fact, a very simple type of reflex act taking place through the agency not of highly specialised nerve-cells, but of ordinary protoplasm and of the delicate protoplasmic fibrils which extend from one cell to another.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Prof. R. B. Clifton, who lately retired from the professorship of experimental philosophy at the end of his fiftieth year of service, has been elected to an honorary fellowship at Wadham College. He has been connected with that college ever since his appointment in 1865, and was an ordinary fellow for the thirty-two years previous to his retirement.

THE Secretary of State for India has appointed Mr. K. Zachariah to be professor of political economy and political philosophy at Presidency College, Calcutta; and Mr. W. A. Jenkins to be professor of physics at the Dacca College.

WE learn from the issue of *Science* for December 3 that objections have been filed to the will of the late Mr. Amos F. Eno, who bequeathed a large sum to public purposes and made Columbia University his residuary legatee. It is said that under the will Columbia University would receive 600,000*l.* or more. Our contemporary also states that a bequest of 10,000*l.* has been made to Cornell University by Mrs. Sarah M. Sage to promote the advancement of medical science by the prosecution of research at Ithaca.

WE have received from Washington a copy of a timely volume prepared by Mr. S. P. Capen, specialist in higher education of the United States Bureau of Education, entitled "Opportunities for Foreign Students at Colleges and Universities in the United States." Students of education will find in it an excellent account of the present facilities for higher education in the States. Every kind of information that an intending student can require is provided. Prominence is given to descriptions of the organisation of a typical American university, living conditions, college life, and college entrance requirements. With reference to the expenses of foreign students, Mr. Capen points out that these vary widely at different institutions. Practically all the privately endowed institutions charge annual tuition fees. The fee is rarely less than 8*l.* a year for collegiate instruction, and in some cases is as high as 30*l.* or 40*l.* a year. Professional instruction, particularly in medicine and engineering, is still more expensive. The Massachusetts Institute of Technology charges 50*l.* a year, and to its students in naval construction and naval architecture 100*l.* a year. Most State-aided institutions charge only a small tuition fee to collegiate students not resident in the State, State residents being generally given free instruction. Living expenses, aside from tuition and other fees, vary with the location of the institution. As a rule, the fundamental charges—room, board, and laundry—are rather lower at country institutions than at those in the cities. The possible wide variations in price are indicated by the figure 18*s.* quoted as the weekly minimum by the University of Minnesota, and 2*l.* 8*s.* the weekly maximum mentioned by Cornell University. The incidental expenses of city living, including amusements, should, of course, also be reckoned.

ON December 9 Mr. Patrick Alexander, well known by his pioneer work in aeronautics, made over to the headmaster of the Imperial Service College, Windsor (Mr. E. G. A. Beckwith), the munificent sum of 10,000*l.* "for the furtherance of the education of boys of the Imperial Service College, *i.e.* for the training of character and the development of knowledge." Mr. Alexander had given to the college an aero-laboratory and equipment about five years ago, but owing to long absences abroad, and a serious illness, he has been unable to identify himself with the college of late as heretofore. Having, however, taken up his residence in Windsor for the last six months, he has been able to continue his research work in the labora-

tory that he so generously gave. It is interesting to note how quickly things aeronautical have progressed since Mr. Alexander's first gift. In the course of an address which he gave on that occasion he said "careful demonstrations with kites and gliders" had been made in connection with the laboratory which he had given, while to-day both kites and gliders have almost been forgotten! But though great changes have occurred, the tribute which he then paid to the Aeronautical Society of Great Britain is, if possible, truer to-day, while his closing words are peculiarly interesting now:—"There never was a time when England held a more dominant sway of mankind, and whether we have to fight on the seas, on land, or in the air, British brains and British boys are as good as they ever were, and the boys going through their training at this college will prove that Old England means to have and keep the supremacy of the air." Mr. Alexander has nominated as his co-trustees Mr. A. A. Somerville (head of the Army Side, Eton College) and Mr. E. G. A. Beckwith.

THE principal of the Northampton Polytechnic Institute presented his annual report at the distribution of prizes to the students on December 18. The report refers more particularly to the work of the session 1914–15. When the enrolments of students were made up at the end of the session, it was found that the total number of students during the session had been 1748, as against 2101 in the preceding session. As usual, the work has received the support of the trades affected. For the eleventh year in succession the principal has been able to place, without payment of any premiums, the whole of the second and third year engineering students in commercial workshops for the summer. In fact, this was easier than usual because by Easter the loss of skilled workers was making itself felt in all engineering trades. A roll of distinction which has been compiled shows that twenty-two members of the staff, 226 students, and 119 members of the polytechnic, making 367 in all, have joined the colours. Of these more than fifty have obtained commissions in one or other of the Services. The roll of honour shows the names of those who have given their lives for the service of their country or who have been wounded in that service. There are seven in the first category and six in the second. As regards the war work being done at the polytechnic, the report points out that courses for drafts from the artillery divisions of the new armies were organised and have been continued down to the present time. The courses consisted of classes in field telephony, in range finding, and in plane table work and map reading. Altogether 897 individual students have passed through these courses, and thanks have been received from Whitehall and from the divisional headquarters, as well as from individual brigades. The manufacture of munitions, also, has been undertaken.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Meteorological Society, December 15.—Major H. G. Lyons, president, in the chair.—F. J. **Brodie**: The incidence of bright sunshine over the United Kingdom during the thirty years 1881–1910. The author described the steady increase in the use of sunshine recorders from the somewhat crude type invented by Mr. J. F. Campbell in the early part of last century to the improved pattern of Sir George Stokes of 1879, which has remained in use with very slight modification to the present day. The paper is based on figures taken from appendix iv. of the *Weekly Weather Report* for 1913, published by the Meteorological Office, and the maps which have been constructed differ somewhat in detail from those appearing in the official volume. The author dealt with the prevalence of sunshine, both by the seasons in their usual grouping, and annually. He also referred to the average number of sunny days at Greenwich and Falmouth, and to the loss of sunshine recorded in London and other large manufacturing centres. He showed that the abatement of the smoke evil tended to an increased record of sunshine, and placed the large towns more on a footing of equality with the urban districts.—Dr. W. **Galloway**: Remarkable cloud phenomena. The author described the curious and rapid changes which took place in a small portion of a thundercloud, witnessed on July 31 last year near Ormesby Broad, Norfolk. The phenomena pointed to the occurrence of electrical discharges, but neither rain, thunder, or lightning occurred.

Royal Anthropological Institute, December 14.—Prof. A. Keith, president, in the chair.—J. Reid **Moir**: The evolution of the earliest Chelles palæoliths of the pointed type from the rostro-carinate implements. A series of ten flint implements from (*a*) the detritus-bed below the Red Crag; (*b*) the stone-bed below the Norwich Crag; (*c*) the Middle Glacial gravel of Suffolk; and (*d*) river-gravels in the Thames valley and at Warren Hill in Suffolk are described, and it is shown that the most primitive type of rostro-carinate has been evolved by gradual stages into the earliest Chelles palæolith of the pointed type. These stages are as follows:—(1) The substitution of a ventral plane formed partly by blows for the ventral plane composed entirely of cortex; (2) the gradual elimination, by flaking, of cortex from the ventral plane, and also the production of a dorsal plane by blows, and devoid of cortex; (3) the gradual reduction in width of the ventral plane until a cutting edge is produced, and the prolongation of the "keel" to the posterior region, accompanied by the disappearance of the dorsal plane.

Mathematical Society, December 9.—Sir Joseph Larmor, president, in the chair.—H. **Jeffreys**: The vibrations of a special type of dissipative system.—F. J. W. **Whipple**: Diffraction by a Wedge.—T. L. **Wren**: Some applications of the two-three birational space transformation.—T. C. **Lewis**: The circles which touch the escribed circles of a triangle.—E. B. **Stouffer**: Semivariants of linear homogeneous differential equations.

Institution of Mining and Metallurgy, December 16.—Sir T. K. Rose, president, in the chair.—E. A. **Wraight**: Influence of heat in cyaniding gold ores. The effect of heat on the dissolution of gold in cyanide solutions is a matter which hitherto has received but scant attention from metallurgists, and the author gives the results of a number of experiments which he conducted with a view to determining whether the application of heat would be beneficial or otherwise. His final deductions are:—(1) That the effect of heating cyanide solutions is of very doubtful benefit; the extraction may be increased for a short period, but this is more than compensated by the increased cyanide consumption and the subsequent decrease in the rate of dissolution of gold; (2) that oxidising agents (hydrogen peroxide excepted) are apparently of no value, and may even exercise a deleterious effect on the extraction; and (3) that the addition of oxygen in a more active form, either as hydrogen peroxide or by means of heated air, increases the solvent activity of cyanide solutions in a very pronounced manner.—A. W. **Allen**: Clay: its relation to ore dressing and cyaniding operations. The presence of clay in so many geological formations, and its invariable association with other metalliferous ores, makes the study of its properties of considerable importance with reference to reduction

processes. In this connection note has to be made of the distinct line of demarcation between colloidal and non-colloidal clay, the former state being inimical to filtration processes generally. After studying the various phenomena of the effect of weathering, adsorption and absorption of metals and of water during dressing and milling operations, their influence on specific gravity and the effect of heat on clay, the author deals with the viscosity of clay, its influence, and the use and value of electrolytes. He adduces from the facts premised in his investigation the highly absorptive properties of colloidal as compared with non-colloidal clay, and the powers which clays possess of retaining liquids and dissolved salts, and he draws the following conclusions:—(*a*) Adsorption of gold solution may occur during treatment, but the main loss is probably due to absorption. This conclusion is strengthened by the fact that (1) non-colloidal clay is only slightly absorbent; (2) colloidal clay is highly absorbent; and (3) burnt clay (*i.e.* after the colloidal envelope has been destroyed) is practically non-absorbent; (*b*) the weathering of clay slime should be avoided except in the instance where the decomposition of refractory mineral is desired; (*c*) clay slime should be allowed an extended time of contact with wash solutions. This precaution is, of course, unnecessary if the ore has been roasted before cyanide treatment.—E. **Maxwell-Lefroy**: Wolframite mining in the Tavoy District, Lower Burma. This is an informing paper dealing with the chief mineral product of the district. Nearly one-fifth of the total world's output of wolfram comes from Tavoy, so that particulars of the occurrence and methods adopted for mining and marketing the mineral should be of interest.

PARIS.

Academy of Sciences, December 6.—M. Ed. Perrier in the chair.—Ch. **Frémont**: A clock escapement of the thirteenth century. The description is taken from a manuscript dating between 1240 to 1251, by a French architect, Villard de Honnecourt. It is more than a century earlier than the clock made by Henri de Vic for Charles V., about 1370.—G. **Moch**: The double detonation of projectiles possessing a high initial velocity. Remarks on a communication on the same subject by M. Agnus, with references to earlier discussions of the phenomenon.—P. **Le Roland** and A. **Carpentier**: An induction apparatus for detecting metallic fragments.—Louis **Malctes**: Electrical influence in a cell with an insulating wall, and with liquid nucleus.—L. **Wertenstein**: The charge of the radio-active recoil.—L. **Tschugaeff** and W. **Khlopine**: The series of hydroxo-platinic salts. The new series is prepared by the action of ozone on Peyrone's chloride $(NH_3)_2PtCl_2$, in presence of ammonium carbonate. The general formula is $[Pt.5NH_3(OH)]X^3$, where X is Cl, (NO_3), etc. These substances have the property of forming insoluble carbonates and sulphates, and resemble barium salts in this respect.—M. **Fleury**: The subterranean hydrology of Alviella.—A. **Guépin**: Results of a shell wound of the brain. Surgical ablation or destruction of a third of the left cerebral hemisphere and subsequent recovery with appreciable nervous troubles resulting.—R. **Desplats** and R. **Paucot**: A radioscopic method for the localisation of projectiles.—Louis **Roule**: New researches concerning the migration of the salmon.—M. **Caullery** and F. **Mesnil**: The structure of a parasitic Copepod, *Xenocoeloma brumpti*, and its relations with its host, *Polycirrus arenivorus*.

BOOKS RECEIVED.

Elementos de Fisica Descritiva para a 4ª E. 5ª Classes. By Profs. F. J. S. Gomes and A. R. Machado. 5ª Edicão, Revista by Prof. A. R. Machado. Pp. 528. (Braga: Livraria Escolar De Cruz and Ca.)

Rainfall of India. Twenty-fourth Year, 1914. (Calcutta: Superintendent Government Printing, India.)

Transactions of the Royal Society of Edinburgh. Vol. l. Part ii. Session 1913–14. Pp. 253–516+plates. (Edinburgh: R. Grant and Son; London: Williams and Norgate.) 27*s*.

The Romanes Lecture, 1915: Science and the Great War. By Prof. E. B. Poulton. Pp. 47. (Oxford: At the Clarendon Press.) 2*s*. net.

Live Stock Journal Almanac, 1916. Pp. 188. (London: Vinton and Co., Ltd.) 1*s*.

City and Guilds of London Institute. Department of Technology, Exhibition Road, S.W. Report on the Work of the Department for the Session 1914–15. Pp. x+451. (London: John Murray.)

Fourth Report on the Cost of Food in the Production of Milk in the Counties of Kent and Surrey. By G. H. Garrad. Pp. 95. (Wye: S.E. Agricultural College.) 2*s*.

New Zealand. Department of Mines. Geological Survey Branch. Bulletin No. 17. (New Series.) The Geology and Mineral Resources of the Buller-Mokihinui Subdivision, Westport Division. By P. G. Morgan and J. A. Bartrum. Pp. viii+210. (Wellington: J. Mackay.)

Canada. Department of Mines. Geological Survey. Memoir 34: The Devonian of South-western Ontario. By C. R. Stauffer. Pp. v+341. (Ottawa: Government Printing Bureau.)

Metamorphic Geology. By C. K. Leith and W. J. Mead. Pp. xxiii+337. (New York: H. Holt and Co.) 2.50 dollars.

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